albert child 7/10

AMATEUR WORK

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SAW BENCH AND BORING MACHINE.

ELMER C. HUTCHINSON.

The amateur woodworker, and especially he who is given to cabinetmaking, soon tires of using a hand saw for getting out his stock, and longs for a saw bench. If possessed of a long purse, he may easily gratify his desire by purchasing one of several excellent makes of machines; but not all of us are so fortunately circumstanced as to be able to do this. For the benefit of those obliged to give careful thought as to ways and means, I here describe a machine—the

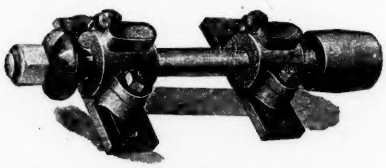


Fig. 1.

second, and decidedly the best one made—which will serve to make easy and rapid much of the work of the amateur furniture and boat builder, and which may be built at small expense and with no great exercise of skill, other than using care to see that joints and fittings are well and accurately made. The table is 30 in. long, 28 in. wide and 35 in. high. The frame was made of 3x4 in. spruce, planed all over, but I would recommend that oak, maple or hard pine be used, as being heavier and stronger. Weight, if not too excessive, is an advantage in a machine of this kind. The saw mandrel, as illustrated in Fig. 1, was purchased; it being necessary to specify that pulley should be on the right end, so that the nut will screw on in the direction opposite to that of rotation. The dimensions here given are for an 8-inch saw; this being about the largest size that can be driven by a simple treadle drive. The saw projects 2 in. above the top of the table, permitting 2 in. plank to be sawed with a slow feed. In place of having two saws, a cross-cut and rip saw, a mitre saw, as illustrated in Fig. 2, was used, as this type of saw gives an exceptionally smooth cut either with or across the grain, and avoids having to frequently change the saw for different kinds of work.

A study of Figs. 3 and 4 will show the frame work. All mortises and tenons should be carefully marked out with a marking gauge, and care used to obtain accurate and tight fit. Cross pieces B, at the top of both front and back, are only partially indicated in Fig. 3, as it was necessary to clearly show the arrangement of mandrel and boring attachment. An ad-

Fig. 2.

ditional piece, C, at the front, a little below the center of the posts A, and another one D, at the back near the floor are needed. These pieces are 26 in. long, and the posts, A, are 20 1/2 in. apart.

The cross pieces on the ends are 28 in. long; the posts A being also 20 1/2 in. apart. The upper pieces, E, are located with their upper edges 2 1/2 in. below to top of the posts A; the pieces F 14 in. below. Attention is called to the locations of the tenons on all the cross pieces; those on B are cut with the upper edge flush with the top, and those on E, with the lower edge flush with the under side. It will also be noted that the piece D, has the wide dimension horizontal.

The treadle requires two pieces G for the ends, 35 in. long, 2 1/2 in. wide and 2 in. thick, which is tapered down to 1 in. thick at the front, starting the taper at the center. Two pieces, K and L, 31 1/2 in. long, 3 in. wide and 7-8 in. thick form the front tread and rear cross piece. These pieces should be very firmly fastened to the ends with heavy wood screws or short lag screws. Slots are cut in the ends G, 3 in. long and 5/8 in. wide, with centers 15 1/2 in. from the rear ends, to receive the treadle rods. Horizontal holes are bored on these centers for the 5/8 in. bolts, which hold the treadle rods. The inner ends of these holes are squared out to receive the heads of the bolts.

rag; not very much oil is needed. The cardboard should come up even against the shaft. The under side is then closed with putty, and the shaft carefully centered. One side is then poured, the babbitt metal being hot enough to flow freely with slow pouring, using care not to close up the opening fully with the metal when pouring, and not to pour too fast. As soon as one side is done, open the box, chip off any featherings; wipe the shaft and babbitt surface with oily rag, replace the cardboards, and pour the other side. The other box is poured in the same manner. When completed, all excess metal is chipped and scraped off, oil groves are chipped parallel to the shaft

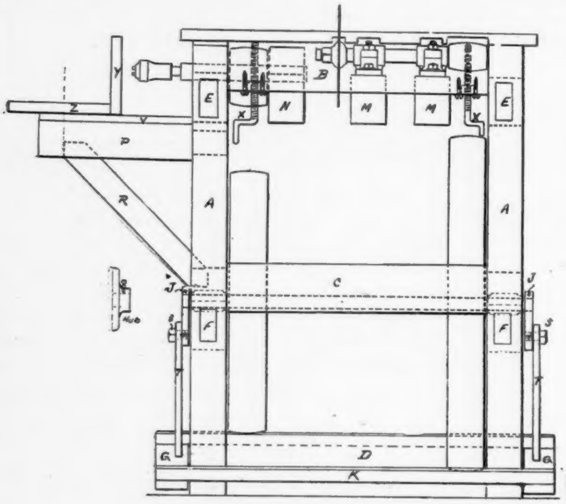


FIG. 3.

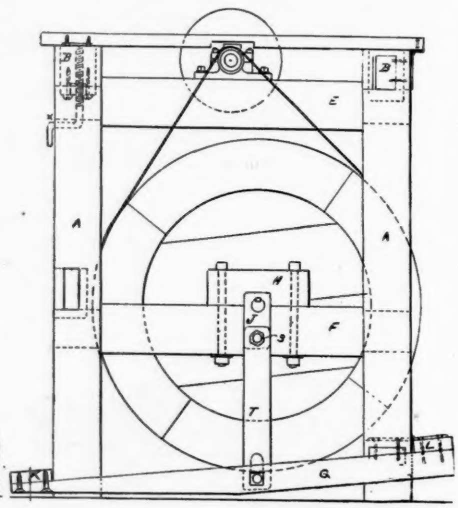


FIG. 4.

in the upper half, and an oil hole bored through from the inner side. If well done, these boxes will wear a long time, and while the process may seen difficult to follow, it will be found easy enough if these directions are followed.

Next in order are the boxes for driving shaft, the center of which is 12 1/2 in. from the inner edges of the front posts. The cap pieces H, are 8 in. long and 2 3/4 in. square. The edges bearing on F should be perfectly flat. Bolts 7 in. long and 1/2 in. diameter are fitted at each end; preferably with the heads sunk into the pieces H. The center point of the shaft is then marked, and 1 1/4 in. holes bored as near the true line of the shaft as possible. This done, remove the caps H, and with a sharp chisel, remove about 1/4 in. of wood in both F and H, leaving a thickness of 1/4 in. at each end. Also bore two or three 1/4 in. holes at varying angles to a depth of about 1/4 in. The boxes are then babbitted, using the shaft for that purpose. The shaft is 27 1/2 in. long, and 1 in. diameter, of cold drawn steel.

To babbitt the boxes, turn the frame on end, wrap paper over one end of the shaft to center it in the lower box, put some pieces of medium cardboard between the cap H and piece F, and bolt down the cap. The shaft should first be wiped over with an oily

The two drive wheels are made in the following manner: The wheel for the saw is 26 in. diameter and for the boring attachment 24 in. diameter, and both 3 in. thick. They are made up of four layers of 3/4 in. oak; the two inner layers of full diameter, with grain crossed, and the outer layers cut in circular form with a width of 4 in. The layers are roughed out with a compass saw, or taken to a mill, if one is convenient, and cut out with a band saw. They are then firmly fastened together with glue and screws. In gluing see that the pieces are clean and warm, and the glue hot. Holes are then bored for the shaft, and the hubs then fastened in place with screws.

The hubs for the drive wheels were cast iron, a pattern being made as shown in Fig. 5. The castings, four in number, were then taken to a machine shop,

where they were bored and faced off on the inner edges, and a hole drilled and tapped in each for a set screw. This method insures a true running and firmly fastened drive. The outer surfaces are turned true and crowned after the treadle is attached, the services of a friend being utilized to turn the wheels while they are being turned true. After turning, should they be out of balance, by turning one or the other on the shaft a balance can be obtained, the weight of the treadle is counterbalanced by boring holes in the rim and pouring in babbit metal or lead after the wheels are turned.

The cranks J are made of two pieces of flat bar iron, 4 1/2 in. long, 2 in. wide and 5/8 in. thick; a hole for the shaft being bored with center 1 in. from end, and a 5/8 in. hole bored and tapped for the stud of the treadle rod, with center 2 1/2 in. from the shaft center. These pieces are keyed to the shaft with round or flat keys as may be most convenient. The studs are short 5/8 in. machine screws, with no threads for about 5/8 in. under the heads. It was necessary to get larger bolts and cut them off to correct length, 1 1/4 under the head. The treadle rods, T are 13 in. long, 2 in. wide, and 1/2 in, thick; 11/16 holes with centers 1 in. from each end being bored for the stud at the top and bolt at the bottom. The hole at the bottom may well be lengthened out to about 2 in. long, so that the treadle will not pinch the foot, should it happen to be underneath on the down stroke.

The supports M, for the saw mandrel can now be made. They differ from the pieces E, only in having the upper corners cut out to fit the under side of pieces B, so that the upper edges will line with those of E. This is also true of the piece N, for the boring arbor. The dimensions of the saw mandrel are carefully taken off and the pieces M, located in the correct positions for holding the bearings of the mandrel. They are fastened to the pieces B with lag screws, holes being bored for same, and washers put under the heads to give a solid bearing. Careful attention must be given to getting the saw spindle in line with the driving shaft, so that the belt will stay on.

The boring attachment may be fitted up in several ways, but the one used was to make boxes with babbitt metal, as for the driving shaft. The spindle was a piece of 3/4 in. drawn steel tubing, double thick walls, but a piece of shafting will answer quite as well. The length is 9 1/2 in. A bit-brace chuck was obtained from a hardware dealer, same being ordered separately. It had aligator jaws and will hold any ordinary bit firmly and true. It was fastened to the spindle by boring out the latter to size to fit the shank of the chuck, and a hole bored through both in which was driven a pin. The bits used in the chuck are ordinary twist bits, with the square taper shanks cut off with a hack saw.

The boring table consists of the pieces P, 14 3/4 in. long, allowing 2 3/4 in. for tenons, 1 3/4x2 3/4 in.; the pieces R, 16 in. long, over all, and 14 in. long on the under side in the clear. Stripes V, 1/2 in. square are fastened to the top of P, a little over 1/2 in. apart, and similar strips to run between them are fastened to the under side of the boring table at each end. The table consists simply of two pieces 28 in. long, Y being 6 in. wide and F 8 in. wide; fastened together with screws, and strengthened with 6 in. angle irons put on the outside. At the center of Y a hole is bored to allow the bits to come through. In using this table, it is necessary to block up most of the work to bring it to the correct height, and for that purpose, several pieces of boards of varying thickness were kept at hand. The services of a friend are also necessary to push the treadle when using the boring attachment for heavy work; the drive wheel being run in the opposite direction to that for the circular saw.

The top of the saw table is 30 in. long, 28 in. wide and 7/8 in. thick. Maple is most suitable, but having some excellent oak on hand, this was used, but is not as clean as maple would be. Two or three boards are carefully planed up, and then glued together in clamps. Cleats 3 in. wide are put on the under side at front and back, so they will not interfere with the frame. The top is attached at the back with two heavy hinges, and ordinarily rests flat on the frame. For rabbeting or similar work, the front is raised by means of the two screws X, which are simply pieces of 3/4 in. iron rod 10 in. long, threaded for about 6 in. and then turned in a vice to form the cranks for turning them. Nuts, sunk into holes cut on the under side of the piece B, and held in place with 1 1/2 in. round head screws receive the screws. Bearing plates over the ends of the screws were made of small pieces of brass, holes being drilled at each end, and the plates sunk into the table top. The saw slot was cut by the saw itself, by slowly leting down the table onto the saw, which was turned rapidly and easily cut the slot. As the saw came through the top of the table the feed was quite slow. It was also necessary to cut the under side of the table to allow room for the belt, and the oil cups on the boxes.

The saw fences and grooves for same were made as follows: A piece of 1 in. heavy square brass tubing was split into two pieces, which were then a trifle over 7/8 in. wide and 3/8 in. deep inside. A grove was cut along the table top to receive one piece of this tube with a snug fit, and it was fastened down with a number of 1/2 in. brass screws, countersinking the heads deeply. This groove was located 3 in. away from the saw. A piece of bar brass 6 in. long, 7/8 in. wide and 3/8 in. thick formed a runner for the groove. In one end a 1/4 hole was drilled and countersunk for a 2 in. screw, which went up into a piece of maple 12 in. long, 3 in. high and 1 1/4 in. thick. On the bottom of this piece of maple, (oak) was fitted a 5 in. half disk of brass, the circumference of which was correct for the screw above mentioned acting as the center. This

disk was cut out of a piece of sheet brass about 1/8 in. thick. In place of a brass disk, a wooden one may be used but will not be as durable. A thumb bolt was fited to a hole bored and tapped on the brass runner, so that the maple strip could be turned to any angle and fastened quickly and firmly in place.

A piece of the remaining half of the square tube 15 in. long was then sunk into the table top at the right side of the saw, and a similar fence made for it, but without the disk as the fence for ripping is always parallel with the saw. Or in place of making the fence in this way, a piece of wood 30 in. long, 2 1/2 in. high and 1 1/4 in, thick may be fitted with brass clamps at the ends and held in place by screwing up, but care must be used in setting it each time.

There is nothing to prevent using the saw mandrel for cutting dado or other narrow mouldings, by securing suitable cutters and a cutter head; also for grooving. A fret saw attachment is being planned and if it proves successful, a description will be given if desired.

A few words of caution about using a circular saw: if you would avoid souvenir markings of carelessness on the hands. Always see that the work is firmly held against the fence, and that the groove is clean so that the work will travel in line with the saw. In ripping, keep to one side of the work, as the strips will sometimes fly back with great force.

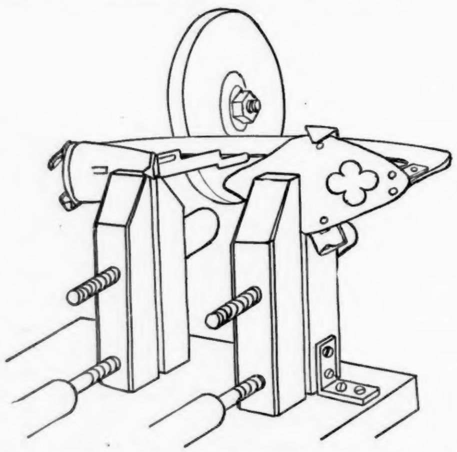
SHARPENING SKATES.

ALBERT T. MACKLIN.

Anyone who has tried to sharpen a pair of skates on an emery wheel knows how difficult it is to maintain one angle throughout the full length of the skate. Many regular skate grinders do not make any too good a job of grinding, because of this difficulty, due to the trouble in supporting the skate when holding it against the wheel. If the following described method is adopted, skate grinding will be made an easy and accurate matter, available to anyone having an emery grinder operated by either hand, foot or water power.

Assuming that it is a water motor grinder, that being the kind used by the writer, who has one which attaches to the faucet, a platform of suitable height is built to temporiarily fit the sink just in front of the motor. No dimensions can well be given for this part of the equipment, as sinks vary so in size, locations, etc. If set laundry tubs in a basement are available, they make an ideal location for grinding, as no necessity for taking off the motor, to meet household demands for water is then likely to arise. The platform above mentioned should be 12 or 15 in. wide, and of a height to bring the sharpening surface of the skate, when placed in the skate holder, slightly below the center of the emery wheel.

The skate holder is shown in the drawing; it is simple, easily made at small expense, and holds the skate rigidly at a uniform angle, as regards the side of the runner, no matter what part is placed against the wheel. To make the holder, buy two 5-inch wooden hand clamps, and cut out a piece of board 9x5x3/4 in. Faster the clamps to the board with 1 1/2 in. angle irons, attached to one jaw of each clamp, as shown. The clamps are located about 1 1/2 in. from each end of the board, and 1 in. from one edge.



The handles to the upper screws, which project towards the back, are cut off at about the center, so that they will clear the emery wheel. The loose jaws of the clamps are also cut off on the lower ends, to enable them to be moved without binding on the board; or thin shims may be put under the rear jaws, before screwing down to the board, thus raising the clamps slightly.

The skate is secured between the jaws of the two clamps, any adjustment to secure the right angle against the emery wheel being made with small wedges placed either above or under the points of contact. other adjustments as to height are made by placing boards of various thickness on the platform previously mentioned. The runner may then be placed against the wheel and rapidly ground by simply moving along the base board with the hands. An emery wheel about 1/4 in. thick is a good size to use, and a moderate presure used, as too rapid cutting may draw the temper of the steel.

All the salt ponds on Turk islands, West Indies, are owned by the government and are leased on a royalty of 70 cents per 100 bushels shipped. This goes into the general revenue; a further tax of 10 per cent. on the industry is charged for the upkeep of the ponds and roads leading to them.

Herodotus says that Croesus was the first sovereign to make coins of gold

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

The young Electrical Engineer, after he has passed the age of batteries, electric bells, miniature motors and the like, has a very natural ambition to design and build a piece of electrical apparatus that may be put to practical use. In looking over the field he finds a machine which at once seems to be the most important one for the production of the electric current, and also seems to be simple enough for his limited ability, to construct.

This machine is the dynamo. It is simplicity itself:—A substantial frame of iron with copper wire wound upon it and a revolving part, also of iron, and some wire coiled on it. The young engineer is very much discouraged, however, when he begins to read various books on Dynamo Design, and is bewildered with the vast array of formulae and theory. The object which the author has in mind in writing this series of articles, is to aid the beginner in his study of this subject by stating the principles in as clear a way as posible, and by presenting the formulae for the simpler and most common form of generators in such terms that they can be readily understood and applied.

The reader must remember that the subject is very broad and full of infinite and intricate detail into which it is imposible to enter in the scope of these articles. It will be necessary, therefore, to make statements without proofs of their truth, but which can be verified by a further study of the subject in other publications. A list of books will be given at the end of the series, the perusal of which, if not the study, we recommend to the student after he has mastered this treatise.

Some of the formulae given have figures in them. They remain the same for any value of the letters, and are therefore called constants. There is a reason for these and the young student must now take them for granted. A study of the more exhaustive books will explain their derivation.

The student should be warned at the start of many of the pitfalls along the path of Dynamo Design. One of the greatest sources of error arises from the fact that most, if not all, the formulae were worked out on the C. G. S. (centimeter-gram-second) system, and must be transposed into the inch-pound-second system, which prevails in this country. The changing is very confusing, and unless care is exercised the terms are mixed and inaccuracy with bad results follow. In this work, however, the formulae are given for inches and no tables or formulae are given for dimensions in the metric system. The latter may be found, however, in other works to which the reader is referred.

Another idea to be noted is that dynamo design is, and is not, an exact science. It is exact in so far as the formulae themselves are concerned, but when it comes to the substitution of numbers for the letters, it becomes a matter of individual judgement or engineering how to choose. The reason for variations or doubt is that the quality of material used varies greatly. For illustration, the ability of iron to carry magnestism varies in different parts even of the same piece.

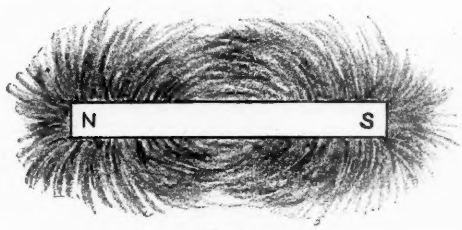


FIG. 1.

The design of the mechanical parts of the dynamo is more a matter of personal engineering than the mere use of formulae. The shape of the frame, the proportioning of the parts one to another, are all matters requiring a personal judgement. Before designing a dynamo it would be well for the novice to study carefully all the different machines, large or small, he can find; the dynamos themselves if possible, but lacking these all the illustrations he can obtain. Find out, if possible, why one is more particularly adapted to a certain kind of work than another; examine critically the mechanical design. The controlling idea should be to design a machine as simple as posible which will perform its work satisfactorily. The revolving parts should be light but substantially built, and designed with a view to withstanding the centrifugal force exerted.

Magnetism performs a very important function in the generation of electricity in a dynamo, and for this reason its principles should be thoroughly understood at the outset.

The name magnet was first given to an iron ore, found at Magnesia in Asia Minor, having the peculiar property of attracting to itself other pieces of iron. Further experiments showed that if a piece of this ore was suspended free, the same end always pointed towards the north. It was also found that a piece of ordinary iron, after being rubbed with the magnet ore, had the same characteristics. The end, therefore, pointing toward the north was supposed to contain "north seeking magnetism" and similarly the other end "south

seeking magnetism." By common usage, however, this has been shortened to "North pole" and "South pole." These two poles are inseparable. It makes no difference how many times a magnet may be cut into parts, each part is found to have a North and South pole.

Many years later it was discovered that a current of electricity passing, by means of a number of turns of wire, around a piece of soft iron, produced the same

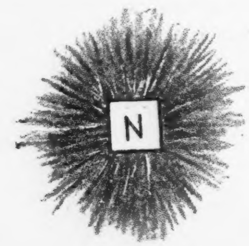


FIG. 2.

effect in the iron, namely, made it a magnet while the current was flowing. This property of the electric current has made posible the size and efficiency of the present dynamo.

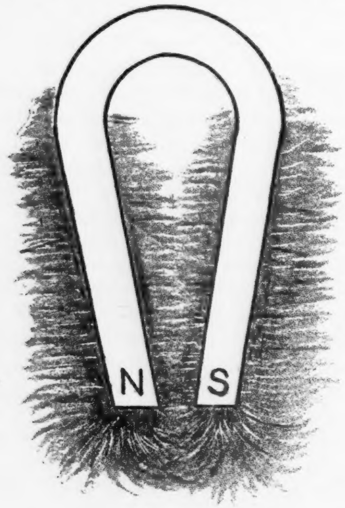


FIG. 3.

It is very evident that a power comes from the poles of a magnet. In order to assist in calculations scientists have assumed that this power eminates in invisible lines called "Lines of force." The number of lines must be nearly infinite and therefore, to further simplify the mathematical work an arbitrary value of one line per unit area has been assumed. These lines of force lie in even, closed curves stretching between the north and south poles. The direction in which they travel cannot be determined, but has been assumed as being from the north to the south pole.

The presence of these lines of force can very easily be shown. Place a bar magnet on the table and cover it with a piece of smooth paper. Sprinkle some iron filings over it and tap the paper gently. The filings will arrange themselves end to end and form smooth curves from pole to pole of the magnet as shown in Fig. 1. If the magnet be placed with its axis vertical to the paper, one pole touching it underneath, and the filings put on, the result will be as in Fig. 2. Fig. 1 shows that the lines of force pass from pole to pole, Fig. 2 shows that they eminate in all directions from the poles. Another point to be illustrated could best be shown by first placing a horseshoe magnet beneath the paper. The irons filings show quite an intense "field of force" between the ends or poles, diminishing as you go down the legs. Now place in position the keeper or "armature," as the piece of iron usually kept across the poles is called, and again sprinkle on the filings. Any rearrangement of the particles is hardly noticeable. This would indicate that the iron is so greatly a better conductor of magnetism that the keeper has taken practically all the lines of force. See Figs. 3 and 4. A particular point which should be noted is that no lines of force cross, all are either parallel or diverging.

FIG. 4.

The discovery has been made, by experiment, that a current passing through several turns of wire about an iron core will produce these same lines of force and further that the magnetizing power of the coil or force exerted by the coil was proportional to both the number of turns of wire and the intensity of the current. Let I represent amperes, S equal turns, k, a constant (a number whose value is the same for all values of the other letters) and H equal magnetizing power, then

$$H = kIS \qquad (1)$$

This is the force exerted at a point. To produce work, this force must be expended through a measur-

able distance as, for example, around a horseshoe magnet. It has been found that the resulting force diminishes in proportion as the length increases. Hence, let L equal the length of the magnetic circuit, then formula **1** will become

$$H = \frac{k\,I.\,S.}{S} \qquad (\,2\,)$$

This is true for all coils or solinoids of moderate length. In coils of excessive length some of the lines of force pass out before reaching the last turns thus reducing the power at the ends. With the length given in inches k will equal 0.3132.

The expression I.S. is called "Ampere turns." It has been found experimentally that the value of H in (**2**) does not vary with the changes in I and S, provided their product remains the same. In other words, if I.S. equals 50, it makes no difference in the resulting magnetizing force whether one ampere flowed through 50 turns, or 50 amperes passed through one turn. This principle becomes very useful in dynamo design and should constantly be kept in mind by the student.

THE PITCH OF SCREW PROPELLERS.

C. C. HERBERT.

The question of the proportions and action of propellers is, on the whole, perhaps the least satisfactory of all with which the marine engineer has to deal. The dimensions of a propeller for any given purpose are usually almost entirely a matter of trial and experiment; as calculations along this line are not only complex, but are not always entirely satisfactory.

The principal features of a propeller may be taken to be:—Diameter, Pitch, Blade Area, Speed of revolution and Slip. The Diameter is that of the circle described by the tips of the blades. The Pitch, considering the propeller to be a portion of a screw, is the amount which it would advance in one turn, supposing it to travel in a solid medium. The Blade Area is the actual area of all the blades.

The Speed of Revolution is customarily reckoned in turns per minute. The Slip is the difference between the amount which the propeller actually advances per turn and the amount which it would advance if turning in a solid medium. For example, if the pitch f a screw is 30 in. it would advance 30 in. at each turn if there were no slip. Suppose that it only advances 20 in. per turn, then the slip is 10 in. per turn, or as it is usually figured in percent, or 33 1/3 percent. As a further example, suppose a propeller of 30 in. pitch turning 300 turns per minute drives a boat at the rate of 6 miles per hour. The advance of the propeller in feet per minute is $\frac{30}{12} \times 300 = 750$, while the advance of the boat is $\frac{6 \times 5{,}280}{60} = 528$ ft. per minute. The slip is then $750—528 = 222$. or as a percentage, $\frac{222}{750} = 29.6$ percent. It might seem at first thought that a perfect screw propeller would have no slip; but this is a practical impossibility; it is also theoretically impossible for a propeller to work without slip.

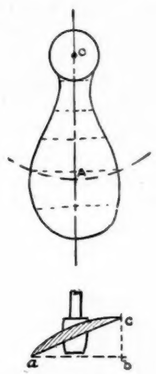
The most important dimension from the standpoint of the absorption of power, is the blade area. A certain blade area may be obtained by a relatively wide blade on a small diameter or by a narrow blade on a relatively large diameter. In the former case the area of the blades bears a greater proportion to the area of the circle through the tips than in the latter case. There are certain limits for this proportion of blade to disc area for well designed wheels beyond which it is not well to go. These are as follows:

For two blades	.20 to .25
For three blades	.30 to .40
For four blades	.35 to .45

This means that for a 24 in. diameter propeller, whose disc area 452 sq. in. the blade area for a three bladed wheel will very from

.30 x 452 136 sq. in. to
.40 x 453 181 sq. in. depending

upon the power to be absorbed by it. The blade area should not, for ordinary use, be made greater than



these proportions as the blades then become so wide as to interfere one with another. Of course, where a propeller must, for shallow draft, be of unusually small diameter, the proportion of blade area must be increased, but at the expense of some loss of economy. Strictly speaking, for a well balanced propeller, the blade area fixes the amount of power which the propeller can deliver, while the pitch, combined with the

turns per minute governs the speed. As a matter of fact, for the average propeller the two are closely related, each having a certain influence upon the other. To illustrate, a propeller may have a small blade area and so great a pitch that the blades act somewhat like fans and simply churn the water, offering great resistance and absorbing the power, but doing little effective work. In this case while the power of the engine is absorbed, but little effort is exerted towards driving the boat. This propeller would be improved by decreasing the pitch to a reasonable figure and increasing the blade area to take up the power.

The opposite case is shown by a propeller of large blade area and very small pitch where the blades are almost flat. Here the blades tend to simply revolve edgewise through the water and the power is absorbed by the surface friction. In this case the engine can turn up to a high rate, but has little effect on the motion of the boat. This propeller will be improved by increasing the pitch and reducing the blade area.

There are certain well defined limits for the proportion of pitch to diameter; for instance, in the 24 in. propeller mentioned above the ratio of pitch to diameter is $\frac{30}{20} = 1\ 1/2$. The pitch should not be less than the diameter nor as a rule greater than 1 1-2 times it.

The blade area is the most important feature, as if this is of the correct amount to absorb the power, the pitch will, within certain limits, take care of itself. This explains why most engine builders can furnish a certain propeller with a certain engine without regard to the conditions under which it is to be used. As a rule the same propeller will be furnished for a heavy working boat, which can only be driven at a low speed, as for a light, high speed launch, and it will appear to work equally well in both cases. This is due to the difference in the slip; in the first case the wheel is working with a large slip, and in the latter case ewith a moderate or low slip, but with a fair efficiency in both cases, provided that the blade area is of proper amount.

An average slip for a good working propeller is usually taken at from 10 to 20 percent. A propeller may work efficiently at a high slip, but the revolutions of the engine may then be unnecessarily high. A slip of over 30 percent will usually indicate that a different wheel would probably give better results. The shape of the after end of the hull also influences the slip, a very full run hindering the flow of the water and increasing the slip. The remedy for this is a larger diameter, to reach out into the clear water beyond. To measure the blade area of a given propeller the center line is drawn down the middle of the blade and the length of the bladed divided into several equal spaces. At these divisions lines are drawn across the blade as shown in the sketch. The widths of the blade at each of the lines is measured, all the widths added together and multiplied by the distance between the cross lines, giving the orea of one blade. This is then multiplied by the number of blades for the total area.

To find the pitch of a propeller it is laid upon a flat surface with the shaft exactly vertical. The pitch at any point, as *A*, may be found as shown in the lower sketch; *A*, *C* is the width across the blade; *C*, *b* is a vertical line at one edge and *a*, *b* is the width on a horizontal line. It is plain that in the distance *a*, *b*, along the circumference, the advance of the propeller is *b*, *c*. The circumfeoence of a circle passing through *A* is 6.28 X *O*, *A*. Now the pitch will bear the same relation to *b*, *c* that the circumference of the circle through A bears to a b or

$$\frac{\text{Pitch}}{\text{b. c.}} = \frac{\text{circumference}}{\text{a. b.}} = \text{Pitch} = \frac{\text{b c} \times \text{circ.}}{\text{a b}}$$

The pitch at different points of each blade is likely to be different, in which case the average pitch is used.

It is hoped that these few hints may be of some help to those who may be unfortunate enough to have unsuitable or poorly designed propellers.

USES OF LIQUID AIR.

At the time of the first commercial production of liquid air, several years ago, a number of untenable claims were made as to its practical applications. One of the most valuable uses to which the liquefaction of air has been put is that of the subsequent separation of the oxygen and nitrogen by fractional distillation and rectification. The possession of such a substance as liquid air, however, has proved of much value in the study of the behavior of various materials at low temperatures. It is generally assumed, for instance, that at very low temperatures metals become brittle and even fragile, and in numerous cases the breaking of steel rails in winter weather has been attributed to this cause. By the use of a bath of liquid air it has been found pacticable to test various metals and alloys at temperatures as low as —180°, and this has led to the discovery that while many steels have their tensile strength increased, their ductility lowered and their brittleness raised at low temperatures, this is not always the case. R. A. Hadfield, a well known British metallurgist, has shown that a nickel manganese steel can be made which will be as tough, if not tougher, at —180° C. than it is at ordinary atmospheric temperatures, and this, too, without material change in the tensile strength. Liquid air has also been used for quenching specimens after tempering, and some instructive information has been obtained about the process of hardening in this way.

Lake Bonneville in Utah, of Pleistocene age, twice filled a basin which is now a desert. The lake at one time covered an area of 20,000 square miles, and was 1000 feet deep.

MERCURY ARC RECTIFIERS.

JOSEPH ALDEN.

A new device has been put upon the market within the last few years for converting alternating current into direct current. This is the mercury arc rectifier. It is quite probable that the readers of this magazine are more or less familiar with its peculiar, greenish light, as they are in use in garages, and many private residences where the electric automobile is used and only alternating current is available. Its chief use at present is the charging of storage batteries, which it does to a degree of nicety that is remarkable, and its high efficiency has reduced the cost of charging considerably.

has a very high resistance. Nevertheless if the vapor becomes electrified or "ionized," it becomes a good conductor, but allows the passage of current in only one direction and that towards the terminal immersed in mercury. Only a few volts are required to sustain this passage after it has been started, but the starting of the arc was a puzzle for a long time to the experimentors. They finally discovered that if a spark was produced between a terminal and the mercury the vapor would be sufficiently ionied to start and sustain an arc from the main anodes. The starting anode was therefore inserted, and by a slight shake contact is made and bro-

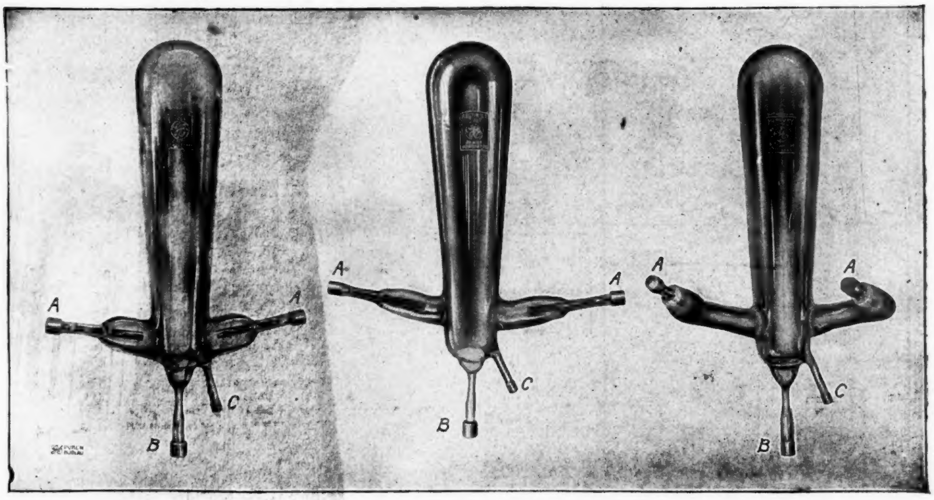


FIG. 1.

The prominent and most important part of the outfit is the mercury tube, which is a glass vessel from which the air has been exhausted. Into this protrude four terminals or electrodes—one at the bottom, one a little way up the side, and the other two on opposite sides and well up on the tube. The electrode at the bottom is covered with mercury, and the one on the side is just high enough so that the mercury will not touch it when the tube is vertical. The terminal at the bottom is the cathode, the one part way up the side the starting anode and the two well up on the sides the main anodes. Fig. 1 is the type of mercury tube manufactured by the General Electric Co.; *A*, *A* are the main anodes, *B* the cathode and *C* the starting anode.

Although mercury itself is an excellent electric conductor, mercury vapor, produced in vacuum by heat,

ken between it and the cathode giving the necessary spark.

To understand the working of the mercury tube, a conception of the nature of alternating current is necessary, so the following explanation is given for the benefit of those not familiar with it. Any complete circuit, whether alternating or direct current, requires two wires. Let these be numbered 1 and 2. An alternating current is one which first goes out on wire No. 1, coming back on wire No. 2; and then goes out on No. 2 and back on No. 1; that is, it alternates in direction between wires No. 1 and No. 2. Two of these alternatious or reversals make a complete cycle, and the number of complete cycles per second is called the frequency. The most usual frequency for lighting at present rate is 60 cycles per second.

The two wires of the circuit are connected to the

anodes, and one end of the direct current load is connected to the cathode. As stated before, the ionized mercury vapor allows the current to pass through it in only one direction, so when the current comes on wire No. 1 it passes into the tube at *A* (See diagram No. 2) and when it comes on wire No. 2 it passes in at A¹. It can be seen therefore that half the alternations goes through from one anode and the other half from the other anode. As only half goes through at a time the direct current voltage will be approximately one-half the alternating current voltage. Theoretically this should work, but experiment has shown that there is

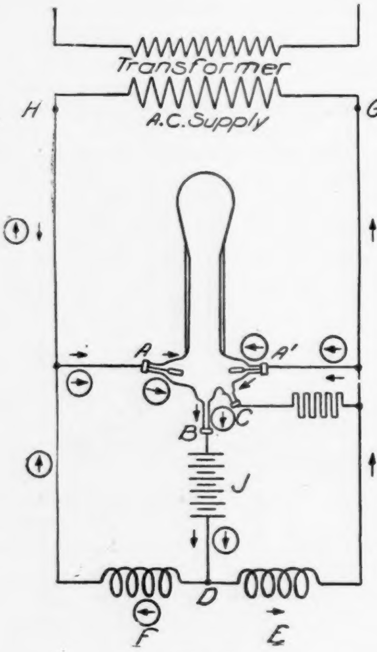


FIG. 2.

sufficient time between the alternations (at the turning point of course the voltage is zero) for the vapor to lose its excitation and the tube would go out. Experimentation was carried on to find if possible a frequency that would work, but the tube would go out with a current having 10,000 cycles.

It was necessary, therefore, to put something in the circuit to bridge the zero point and the two coils *F* and *E*, were introduced. These have what is termed capacity, that is, they can store up voltage while the main current is increasing, and discharge it into the tube while the main voltage is at zero. The other terminal of the direct current load is connected between the reactances. The operation of the complete rectifier outfit can now be explained by diagram No. 2. In this the two directions of the alternating current are represented, one by a plain arrow and the other by an arrow in a circle. The current can be assumed as first starting from *H*, and is shown by the plain arrow. It passes into the tube at *A*, out at *C*, to the load *V*, through the reactance *E*, thence back to the source. Reactance *E* stores some of the current, and when the main current comes to zero it discharges into the tube at A¹, serving to keep the tube going until the main current builds up again in the opposite direction, as shown by the arrow in the circle. The operation is thus repeated for the other

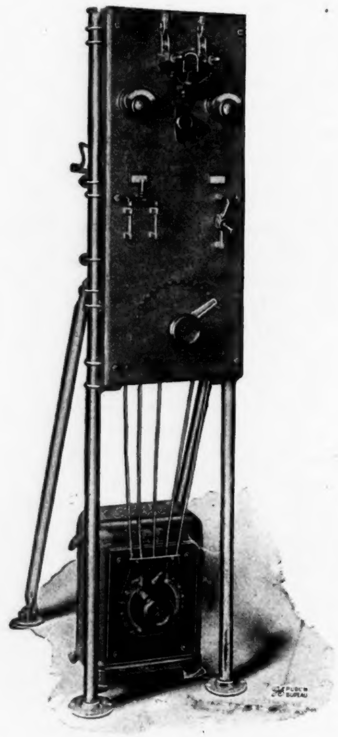


FIG. 3.

alteration, using reactance *F*, and a cycle is completed. This action repeats for every cycle in the alternating current.

A resistance is connected between the starting anode and the line, which allows just enough current through to start, but prevents a short circuit. Various devises are introduced into the circuit for the control and regulation of the output.

Theoretically this rectifier should have an efficiency of 100 per cent.; that is, the volts, X the amperes, direct current, or power, should equal the volts X the amperes, alternating. This is not so, however, due to a slight loss in the reactance, and also to the fact that it requires a certain number of volts to maintain the current in the tube. The efficiency obtained, however, is in the vicinity of 75 or 80 per cent. for high D. C.

voltages, which is very good and very much better than any other small converting outfit.

Although it is used mostly for charging storage batteries, it is also being used to run lights, small motors, and similar work. It is necessary, however, to keep a small constant load on the tube all the time it is in use, as it would go out if the motor, for instance, was shut

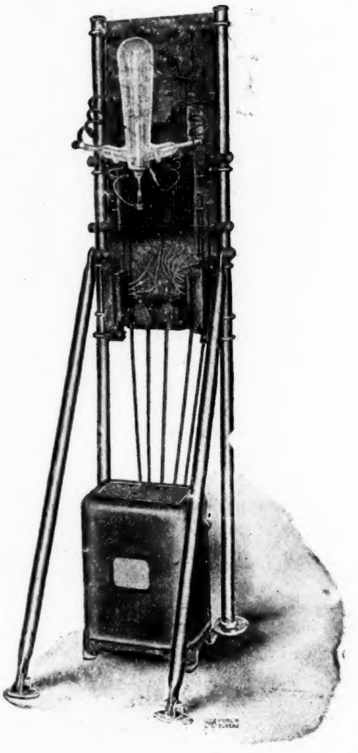


FIG. 4.

down or lights turned off. The General Electric Co. is making small outfits for running direct current dental motor drills, the size being very handy for experimental work as well.

Figs. 3 and 4 show the front and back view of a Mercury Arc Rectifier Panel, made by the General Electric Co. for charging storage batteries. With 110 volts A. C. it will give 40 Ameperes at about 46 volts D. C.; with 220 volts A. C., 40 Amperes at about 115 volts D. C.; and with 330 volts A. C., it will give 40 Amperes at 175 volts D. C.

The instruments on the panel are as follows: at the top, the circuit breaker in the D. C. lines, next the voltmeter and ammeter, then a hand wheel for shaking the tube; which is mounted on the back. On the next line the switch at the left controls the A. C. line, and the switch at the right is for starting. Next it a series controlling reactance, which is inserted in the A. C. line to get fine variations in voltage. Beneath the panel is the main reactance. The back view shows the tube and series controlling reactance mounted on back of the panel.

Fig. 5 shows the connections of this panel, the diametric location of all the different devises; and also a table of connections, whereby it is possible to obtain many different D. C. voltages.

Since the D. C. voltage is about a half the A. C. voltage, the D. C. current is about twice the A. C. current. The 75 to 80 per cent. efficiency is obtained only where nearly the maximum D. C. voltage is used. The efficiency will, therefore, go down as the D. C. voltage

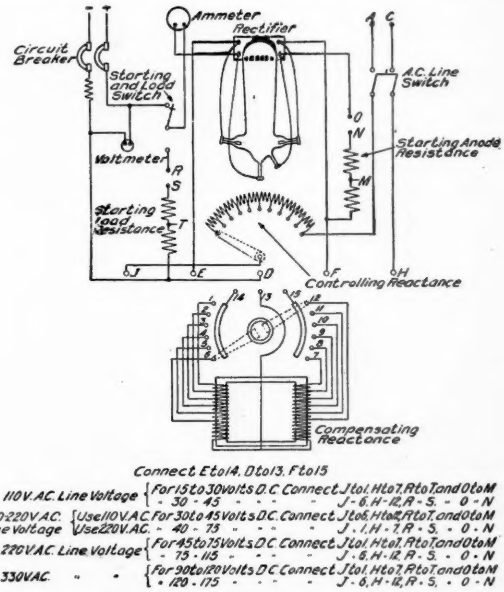


FIG. 5.

is lowered, as it is impossible to raise the current beyond the tube capacity. There are four sizes of tubes, 10, 20, 30 and 40 amperes. An attempt to take more than the rated current would heat the anodes and break the tube.

The latest development of the mercury tube is the use in connection with constant current transformers and series arc lamps. With this combination it is possible to get a direct current for the arc lamps and yet have an alternating current source. The direct current arc lamp is much better than the alternating current lamp, as it gives a much steadier lamp, and is free from the humming which is always present in the alternating current lamp. A number of these outfits have been installed, and are giving very good satisfaction.

Before the days of coined money the Greeks used copper nails a scurrency.

SOME FACTS ABOUT VARNISH.

GORDON MONTAGUE.

The word "varnish" is understood to be derived from the Latin vitrinere, meaning to glaze or produce a glass-like surface. Of the greater variety of gums used in the making of varnish, shellac is the most useful for spirit varnishes. Although the annual consumption of gum shellac in this country is now about 5,000 tons, there are points about it not generally known or understood. It is not a resin in the strict sense of the word; i. e., it is not the simple juice of a tree, but results from the action of certain insects on the juice and contains several very peculiar resins.

Next to shellac sandarac ranks as the most valuable gum for spirit varnishes. As for the regular gums, although the list in books is a long one, practically all that varnish makers are interested in may be counted on the fingers of the hands, and this can be further reduced to four, viz., Zanzibar, Kauri, Manila and Damar. The impression prevails that great quantities of these gums are shipped to the American market, but such is not the case. The imports for the year 1905 were not much in excess of 13,000 tons, and of this about 50 per cent. was Kauri.

Zanzibar stands at the head, being the hardest of all gums, except amber, which need not be considered. It derives its name, as may be inferred, from the port of shipment, as indeed most other gums do, excepting, perhaps, Manila. We speak of all these hard gums as "fossils," because they are found in a fossilized condition in the ground, sometimes hundreds of feet below the surface. Zanzibar is dug out of the sands of the African desert, and the curious indentations which give this gum the appearance of goose skin are simply sand impressions. The Zanzibar gum is scarce and very expensive.

Next in point of costliness, but far in advance in point of usefulness to the varnish maker, are the New Zealand copals, commonly called "Kauri" gums. They range in color from a creamy white to a dark brown, and are so graded. Much of this gum is not available for use, and the assorting requires skill and care. The lower grades contain pitch and swamp gum, the former being taken from the forks of trees 100 feet or more above the ground. It is a soft, spongy mass, and it is extremely difficult to incorporate with the oils. Ninety per cent. of what is imported, however, may be classed as good hard gum, differing only in size, color and clearness.

Manila gum is a soft copal exported from the Dutch East Indies. It is in more or less demand, but varnish makers have no great use for it. However, a small quantity sometimes helps to give elasticity to harder gums, and occasionally it is used in spirit goods. For general use its greatest drawback is the difficulty of eliminating the pyroligneous acid, of which it carries quite a large per cent. There are many other varieties of gums in the same class as Manila, but they are not used to any considerable extent, perhaps 1,000 tons would cover the annual importation.

The blacks are a small line mostly used in baking or air drying japans and varnishes. Originally our supplies of asphaltum, which is supposed to be the product of decomposed animal and vegetable matter, came from the shores of the Dead Sea, and "Egyptian" continues to be one of the best grades. We now get a considerable quantity from both Trinidad and Barbadoes, and Cuba sends us an asphaltum that is densely black. In this country Colorado and Utah mine very heavily. There are other blacks besides asphaltum, but as a rule they do not interest the varnish maker—such as coal tar pitch, resin-pitch, candle-pitch, etc. There is more or less interest attached to all these crude materials which enter into the composition of varnish, but space will not permit of my dwelling on them at length. One other, however, I will mention—China wood oil. This is a much more expensive oil than linseed, and very hard to manipulate to get proper results, but is none the less a most valuable article for those varnish makers who have mastered its secrets. When worked in the same way as linseed oil it makes a harder, more elastic and more durable varnish.

As for the different grades of varnishes, the numerous catalogues which are issued show what a large variety of varnishes there are for sales purposes; but the classification may be considerably modified. Originally there were but two classes on the market—carriage varnishes and furniture varnishes. The introduction later of so many beautiful woods in building operations made an architectural line imperatively necessary. Outside of the above the manufacturers' lines and specialties make an almost endless list; yet they are all modifications of a general line to suit certain conditions and for the most part are obtained by blending.

All the better grades of varnish, no matter what the line, are made of selected gums and are specially prepared oils, with pure turpentine as a thinner. The cheaper grades will naturally carry poorer gum, and be thinned with either naphtha or part naphtha and part turpentine.

Speaking of naphtha and turpentine thinners, it may be interesting to know what the essential difference is. The turpentine varnish undoubtedly works easily, and it dries from the bottom up. With naphtha these features are reversed. Sometimes it forms a skin over the top, keeping out the oxygen, and so retarding

the drying. Another serious fault with naphtha goods is that they do not flow as turps does. Both, however, are used merely as distributers, for neither stays where it is placed, but evaporates in due course. Most of the difference between the two liquids lies in the fact that turpentine carries a percentage of oils and naphtha does not. It is easier and better to thin with turps because it can be added at a higher temperature—350° to 360° Farenheit—and at this temperature the combination of gum and oil is more perfect.

There are many terms in the technology of varnish which convey no definite meaning to the outsider; yet they are full of suggestions as to the possibility for use of said varnish. For instance, the varnish maker speaks of "slack melt." By this it meant that the gum is melted in a covered kettle to a semi-liquid condition before the oil and thinners are added. The result is a large yield, good color, hard working and a false body. The batch takes a large quantity of thinners, which in itself causes a loss of gloss. The object is simply good color, or large yield, or both. There is more or les moisture left in this varnish, and if mixed with pigment it would be apt to liver. If it did not do that it would not mix well. So for this purpose the using of a "slack melt" is to be avoided.

An "open melt" is when the cover is left off the kettle, the object being to throw off as much moisture and copal oil (the oil that is in the gum) as possible. When this is not done the varnish is liable to "bloom," and the oil mentioned retards the drying.

For a "close melt" the cover is left on and a larger yield is produced, as most of the gum is retained in the kettle. This is used for the cheaper grades than the best. Good results are also obtained in a "close melt" by different manipulation. One way is to melt the gum to a liquid state before the oil is added. In doing this color and yield are sacrificed to a certain extent, but finer results are produced as to gloss, drying, freedom of working and wearing qualities. In all gum melting too strong a fire is to be avoided or the gum will be burned.

Zanzibar and other fossil gums are difficult to handle. Usually the heat varies from 550° to 640° for the harder gums. Japans (outside of the grinding varieties, which are made with shellac and gums) and liquid dryers are usually made by boiling lead and manganese with linseed oil, combining as much metal as possible with the oil, and driving off the oxygen with long sustained heat.

It is a truism that good varnish depends more on the makers than on the material. This has frequently been proven, since with the same material one man has made a good varnish and another a very poor one. Thoroughly competent men for this work are scarce. It requires brains, nerve, judgment and a perfect knowledge of materials—not merely the crude material, but of the finished product, and what it has to accomplish. He must be weather wise also, for under certain circumstances the weather is a most important factor to consider. For instance, the atmosphere indicates posible mugginess, with little or no draught. He realizes at once that he must make up the strongest kind of a fire before he runs the kettle on, otherwise the contents will simmer, darken and spoil. Or again, he may wish to make a varnish of another class, which requires a bright, clear day, with not too much wind. The successful varnish maker must be able to cope with all of these conditions. He must be a man of discernment, capable of perceiving possible danger or loss before the actual crisis arrives, and a man of resource, so that he can constantly meet, counteract and overcome any troubles which may arise to hinder the successful making of his varnish.—"American Exporter."

ARTIFICIAL RUBBER FROM CEREALS.

Consul F. W. Mahin reports from Nottingham that according to a current newspaper item an inventor named Carr, in Middlesex, proposes to make artificial rubber from cereals—wheat, corn, etc.—for use as bicycle and automobile tires, and also as golf balls.

It is explained that the artificial rubber is obtained by treating any cereal with phyalin. It is reported that a syndicate of capitalists, interested in tire manufacturing, has offered Mr. Carr over $1,000,000 for his patent rights. The inventor's response is not stated. Mr. Carr, it is announced, proposes to make six grades of artificial rubber from a liquid solution suitable for waterproofing to a hardness available for golf balls. In the latter the substance is credited with the lightness of cork and the toughness of chilled steel. The intermediate grades are expected to be serviceable for tires, tubes, linoleum, and slabs or sheets for pavements.

Prof. Alexander Winchell is credited with the invention of a cement that will stick to anything. Take two ounces of clear gum arabic, one and one-half ounces of fine starch and one-half ounce of white sugar. Pulverize the gum arabic, dissolve it in as much water as the laundress would use for the quantity of starch and sugar in the gum solution. Then cook the mixture in a vessel suspended in boiling water until the starch becomes clear.

The cement should be as thick as tar, and kept so. It can be kept from spoiling by dropping in a lump of gum camphor or a little oil of cloves or sassafras.

This cement is very strong indeed, and will stick perfectly to glazed surfaces and is good to repair broken rocks, minerals or fossils. The addition of a small amount of sulphate of aluminum will increase the effectiveness of the paste, besides helping to prevent decomposition.

Julius Caeser was the first man to engrave his own image on a coin.

A 75-WATT DYNAMO.

IRA M. CUSHING.

The dynamo here described is designed to light 14-volt miniature series lamps connected in multiple; driven at a speed of 2800 R. P. M. it will give 5 amperes at 15 volts. The accompanying illustration gives the outline and important dimensions.

The field frame and base should be made of a good grade of cast iron and cast in one piece. The frame and bearings should be made and assembled as described for the 150 Watt dynamo in the December number of Amateur Work. The bore of the field should be a scant 2 1/8 in. or 2 3/32 in. The closer to the latter figure the builder can come, the more efficient the machine will be.

There is only one difference between the bearings for this and the 150 Watt machine. The shaft for this generator is .3125 in. diameter in the bearings. The brass tube for bearing lining should therefore have an internal diameter of less than 5/16 in. in order to bore it out for a running fit.

Another way to make a good bearing would be to run melted babbit or bearing metal into the bearing in place of the brass tube and when cool bore out for the shaft. In boring use a size smaller drill than required and ream to a running fit.

For lubrication, an oil hole should be drilled through the top of the bearing. If the generator is to be run very long at a time this hole can be tapped and fitted with a grease cup or a wick feed oil cup.

The shaft is aproximately 10 in. long and .3125 in. diameter in the bearing. The enlarged portion begins 4 3/8 in. from the commutator end and is 7/16 in. in diameter. This part is 2 1/2 in. long. At the commutator end of the large part is cut a No. 14 thread for about 5/16 in. The nut and retaining washer should be 1/4 in. in diameter and assembled as on the 150 Watt dynamo, the edge of the washer to be 1/4 in. from the pulley end of the enlarged portion.

The armature core is made up of enough sheet iron punchings to fill tightly the space of 1 1/2 in. The punchings are 2 1/16 in. diameter with 12 5/16 in. holes in the periphery, with their centers on 1 3/4 in. diameter circle. The assembling and insulation of the core should be as for the 150 Watt dynamo.

The commutator and brush holder rigging described and illustrated for the 150 Watt machine, will be correct for this generator with a slight change. The brass tube upon which the commutator is built should have small enough inside diameter to be bored out for a driving fit on the shaft. Otherwise the yoke, studs, brush holders and brushes will be of the same size as before described.

Wind the armature with No. 20 D. C. C. magnet wire putting 34 wires in each slot. Since this core has the same number of slots as the 150 Watt dynamo the winding scheme will be the same. There will be six coils with 34 turns in each coil. Calling the slot No. 1 where the first coil starts the six coils will fill the slots as follows:—Coil 1, 1—16; coil 2, 11—4; coil 3, 9—2; coil 4, 7—12; coil 5, 5—10; coil 6, 3—8.

Much care should be taken in winding to lay the wires straight, even and tight. If the finances of the builder would allow I would recommend double silk covered wire. This would give more leaway for getting all the wire in the slots, as the double silk does not take up as much room as the double cotton. Single cotton covered wire can be used but great care must be exercised in winding not to break the insulation. Insulate the shaft each side of the core; at the pulley end with tape and at the commutator end with a fiber tube 3/8 in. long and 5/16 in. inside diameter. Carefully test each coil for a ground with the core as it is wound.

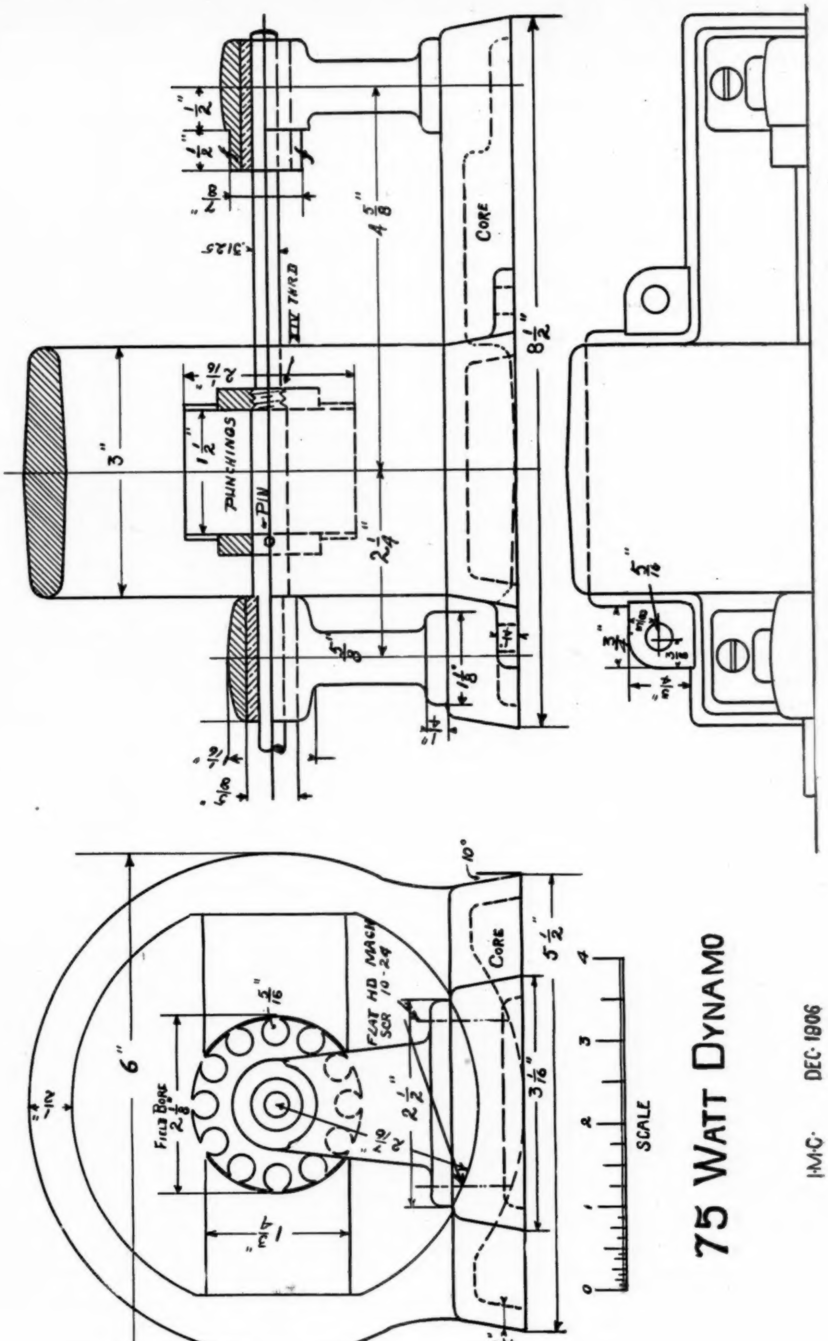
Testing each coil as wound may save rewinding the whole or part of the armature to remove a ground. This test should be made with a voltage of at least 30 volts, but 110 volts is better if at hand. Have a lamp in series with the testing wires when using 110 volts, as otherwise the worker may get a severe burn in case of a ground. Besides, the lamp will readily indicate the ground.

The commutator should be assembled on the shaft and connected to the windings as on the 150 Watt dynamo, connecting the end of a coil to the segment next beyond. In winding and making connections neatness is a very important factor. It not only gives a better appearance to the machine but it also results in a better working machine. Wires that are laid evenly, straight and tight will stay in place very much better than wires laid haphazzard.

The field should be wound with 714 turns, or more, of No. 20 S. C. C. magnet wire to each pole. Wind the poles as full as possible; if more than the above number of turns can be put on the more efficient will be the dynamo. The same method of winding should be followed on this machine as described for the 150 Watt generator. This and the 150 Watt dynamo are shunt wound machines, and so the connections of field and armature will be the same.

Use a 1½ in. pulley with a 1½ in. face and drive with a 1 or 1¼ in. flat belt. Determine the direction to drive the dynamo by applying current from 10 or 12 dry cells, or any source having 15 volts. It will run as a motor in the same direction as driven for a generator.

The field winding will require approximately 4 lbs. of No. 20 wire and the armature will require about 1/2 lb. of No. 20 wire.


CORE
PUNCHINGS
PIN
THRD
3"
4 5/8"
2 1/4"
8 1/2"
6"
5 1/2"
3 1/16"
2 1/2"
FIELD BORE 2 1/8
FLAT HD MACH SCR 10-24
CORE
SCALE
75 WATT DYNAMO
H.M.C.
DEC 1906

AMATEUR WORK.

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JANUARY, 1907.

SKILLED OR UNSKILLED.

The present strenuous condition of manufacturing finds the supply of skilled labor entirely inadequate to meet the demand, and employers are obliged to accept even the most ordinary applicants and pay them full journeymen's wages, that orders may be filled without too great delay.

The city of Boston recently opened a free employment bureau, and during the first two days, over 1500 applicants for work were registered, of this number about 1100 were young men, physically able and willing to work, but possessing no vocation; that is, were classed as "unskilled." Quite a large proportion of this number had received a common school education; a smaller number were graduates of grammar and high schools. All professed to be anxious for work of any kind, but unable to obtain it, largely owing to lack of skill.

The coincidence of these two conditions points a lesson to every youth in the country; one also, which parents should consider to a far greater extent than is generally the case. Had the applicants for work at the employment agency been trained in any of the leading trades, all would have been able to obtain employment at good wages, and the manufacturers of the country would be able to enlarge their output to more nearly meet the demands.

The underlying cause for a lack of skilled labor and an excess of the unskilled, may be, to quite a large extent, traced to the desire of school graduates to obtain a "position," and "overalls" are not looked upon with much favor. The error in such views is not seen until later in life, when the skilled mechanic, shop foreman or superintendent enters a store and from a well filled purse, pays a former school companion for a tool or article purchased.

The difference between a skilled craftsman and a store or office clerk lies in the fact that the former possess in his skill something for which there is always a demand, and which alone will bring advancement and increased reward. It differs from the knowledge of merchandise or office routine acquired by a clerk, in having a much wider field and more fixed scale of remuneration, making the matter of employment largely one of skill rather than locality or time.

The clerk without employment, on the other hand, must search until an opening is found of a like or similar nature to that for which he has been trained. Conditions may be such that this is a very difficult thing to do, and the personal necessities so pressing that some other and less desirable kind of work be taken.

In the way just mentioned arise that large class of "unskilled," or only partially skilled or trained; the degree of skill or training not having reached a point sufficiently in advance of a multitude of others to command a sure place in the industrial system. It is quite probable that in the near future the opportunities and inducements for learning trades will be greatly enlarged, and anyone desiring information regarding opportunities for learning a trade will be given every possible assistance.

The supply of complete sets of bound volumes of this magazine are being rapidly disposed of. They supply more information of value to the amateur than can be found in other books costing many times the price. If you wish for a complete set, send in your order at once. Sets will be sold in partial payments of $2.00 per month for four months, to anyone furnishing two acceptable references.

Owing to the large demand for castings for the dynamos being described by Mr. Ira M. Cushing, we are having patterns made up and shall be able to offer the castings and parts as premiums at an early date.

Be sure and enclose stamp for reply to letters of inquiry. No reply will be sent to postal requests, other than those relating to the magazine.

An increase in size of four additional pages in this number.

The shadings of all colors begin with white and end with black. White may, therefore, be considered as the color from which all other colors emanate and black as the one in which all others disappear.

Homer mentions brass money as in use 1184 B. C. among the Greeks.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

VIII. Lubrication and Lubricating Devices.

The question of lubrication is one of vital importance in gasoline engine operation. The thoroughness of the lubrication has a very direct effect upon the life of the engine. An engine may be badly damaged by a short run because of insufficient lubrication. The cylinders especially must be well lubricated, as a lack of lubrication under the extreme heat conditions will cause the piston to stick and finally cut the cylinder.

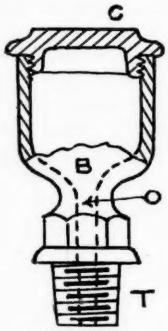


FIG. 53.

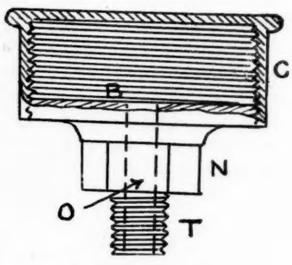


FIG. 54.

The principle means for feeding the oil are illustrated in Figs. 53, 54 and 55. The first, or plain oil cup, is simply a brass casting *B*, screwed into place by the thread *T;* the screw cap *G* allows the body to be filled with oil, which gradually feeds down to the bearing through the hole in the stem. This style can be used for ordinary bearings where there is no outward pressure. Fig. 54 shows a grease cup for feeding the solified grease. It consists of a cap *C*, which is threaded inside over its entire surface. The end of this cap is closed by the flat disc *B* which fits the interior thread and is provided with a stem and thread end *T*. In operation, the cover *C* is filled with grease, and then screwed down over the disc *B*, the pressure forcing the grease out through the hole*O* in the stem and on to the bearing. The cover *C* can be gradually screwed down until all of the grease is exhausted. This form is used where the pressure on the bearing is great, as on the main journals.

Fig. 55 shows a sight feed oil cup for feeding oil against pressure, as to the cylinder. It consists of a section of glass tube, *G*, closed at the ends by the heads *C* and *F*. The entral tube is a projection from the lower bead *T*, having its upper end threaded, over which the head *C* screws. The head *C* is screwed down tightly, with a ring of packing placed under the edges of the glass *G* to make a tight joint.

A threaded stopper *f* allows the body to be filled with oil, which can flow through the small opening *o*, down through the central opening and so down to the bearing. A section of smaller glass tube *g* is inserted, as shown, and the body has a circular opening *o* through which the flow of the oil from above may be observed. A side tube *P* leads from the lower chamber

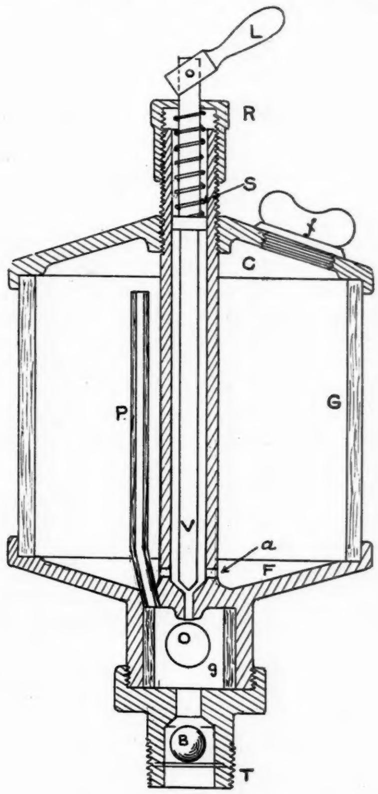


FIG. 55.

up above the body of the oil to admit the pressure and prevent the formation of a partial vacuum above, which would finally prevent the feeding entirely. The small plunger *V* fits into the seat just below and is held in place by the coiled spring *S*.

The lever L is pivoted to the end of the plunger V; when this lever is horizontal it is free and the plunger *V* is in its seat, stopping the flow of oil. When *L* is raised to a vertical position it raises the plunger *V*

and allows the oil to feed. This lever *L*, in its upright position, bears on the top of the cap *R*; this cap is threaded on the end of the central stem, and may be raised or lowered, thus regulating the amount which the plunger *V* is raised by the lever *L*.

The ball *B* is designed to prevent a sudden inrush of pressure by being carried up into and closing the opening just above. The whole device is, of course, exposed to the same internal pressure, so that the oil

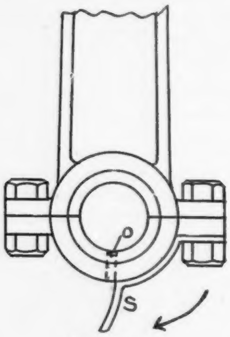


FIG. 56.

can feed by the action of gravity. The ball *B* prevents the pressure blowing through into the cup above and allows the plug *f* to be removed and the cup filled while the engine is running. By turning down the lever *L* the supply may be stopped when the engine is not running.

The lubrication of the cylinder is done by means of a sight feed cup so placed as to deliver oil at a point near the middle of the piston stroke. This oil cup is

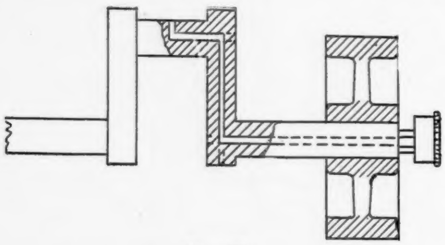


FIG. 57.

shown at *O*, Figs. 8, 9 and 11. The lubrication of the piston is one of the most important and is perhaps the most difficult point to lubricate.

The high temperature of the cylinder, which is estimated at at least 1500 degrees, is sufficient to burn almost any kind of oil. The carbon deposit thus formed gathers in the counterbore, and passages, and on the igniting gear or spark plug; such a mass of carbon will frequently become heated and fire the charge during the compression stroke, causing pre-ignition. The gathering of the soot on the sparking points also insulates them and partially or entirely prevents sparking. Cylinder lubrication and, in fact, all lubrication is improved by a judicious use of graphite. This substance has the quality of filling up the small pores of the iron and rendering the surface smooth and glassy. A new cylinder especially is greatly benefited by the use of graphite, as with even the most careful finishing of a cylinder there are innumerable minute cavities, each of which is a small producer of friction. Graphite will fill up these cavities and give the surfaces of piston and cylinder the glassy effect which denotes the proper condition. The smoothness of the surfaces allows a better fit of the piston rings, which increases the compression. The lessened friction also increases the life of the cylinder.

Graphite may be fed into the cylinder with the oil through the regular cup. This, however, is not advisable, as it is apt to clog the small openings and an independent method is desirable. If a priming cup is fitted to the engine the graphite may be fed through it after being mixed with a small amount of kerosine or cylinder oil. It may also be fed in through the spark plug opening, but care must be taken to not allow any flakes to lodge upon the spark plug, which will cause a short circuit. It is not always advisable to depend upon the graphite alone, but by its use less oil and a thinner oil will be needed, with proportionately less trouble from carbonization.

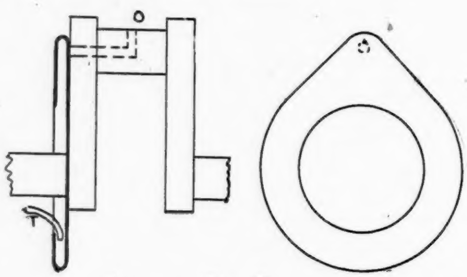


FIG. 58.

The wrist pin as a rule requires and receives scanty lubrication. An axial hole is usually provided with a radial hole opening into the bearing. Oil from the cylinder walls is supposed to work its way along this hole and into the bearing; very little, however, can do so. The rotation of the rod is slight, however, and much oil is not required.

The crank pin is lubricated in one of several ways, the most common of which is the splash system, mentioned in connection with Fig. 8, a detail of which is shown in Fig. 56. The small scoop *S* is made of sheet metal, and held in place by the bolts as shown. The base is partially filled with oil, a small portion of which is scooped up at each revolution and delivered to the bearing above through the small hole *O*. The direction of revolution is shown by the arrow. By the splashing of the connecting rod, some oil is also delivered to the cylinder walls. A very reliable method

of crankpin lubrication is illustrated by Fig. 57; a small hole is drilled in the center of shaft, crank and pin to the surface of the crankpin bearing. It is drilled, as shown by the dotted lines, and plugs inserted to close the openings. This hole extends through to the front of the engine where a grease cup is fitted into the end of the shaft; in this way the grease may be placed directly upon the bearing. This method is good, but is somewhat in the way when using the starting handle. Another idea, which is used on some high grade engines is shown in Fig. 58. It consists of a shallow receptacle with an open centre forming a sort of ring, which is fastened to the side of the crank. This receptacle is drawn out at one point, at which there is a hole communicating with the axial hole *O* in the crank pin. Oil is delivered into the lip by the tube*T* from an oil cup above. As the shaft revolves the oil is thrown into the circumference of this ring and finds its way to the bearing through the hole *O*. In this way a continuous feed may be had.

The main bearings of two cycle engines are usually fitted with grease cups, as at *G* in Figs. 8. 10, and 11, mainly because the grease by its viscosity prevents the loss of base compression by leakage through the bearings. Where an open base is fitted, as in Figs. 16 and 17, a cup for oil may be used as at or even a cup like Fig. 53.

On engines with several cylinders it is customary to fit a multiple sight feed oiler, having several supplies, each operating like Fig. 55. Each important bearing is then fed by a separate supply.

There are several varieties of forced feed oilers consisting of several small pumps run by a common shaft and each supplying a bearing. The shaft is run by gearing or belt from some part of the engine. The use of the forced feed oiler assures a steady supply to each bearing, and this supply stops automatically on the stopping of the engine.

The smaller bearings are fitted with the screw cap oil cups or simply a countersunk hole to receive a few drops from an oil can.

It is a practice of some people to mix the lubricating oil with the gasoline in the proportion of about a pint of oil to five gallons of gasoline. The presence of the oil seems not to affect the vaporization, and the oil is thus carried to all the working parts of the engine which are in its path. It also avoids the necessity of filling and watching the oil cups.

The question of the amount of lubrication is a matter of experience with the particular engine in operation and can only be settled after a considerable amount of experiment.

MORTISE AND TENON JOINTS.

A tenon is a tongue or projection of reduced size formed at the end of a piece of wood, and a mortise is a corresponding slot or recess cut to receive it in the side of another piece. The end of the tenoned piece thus fits into the mortised piece, preventing lateral movement of the parts in relation to each other, permitting them to meet in the same plane, and forming a joint which can easily be held together by glue, pins, or other means.

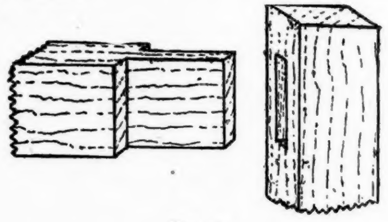


Fig. 1.

These joints are very common in carpentry and joinery, and in a less degree in pattern-work. They are suitable for framed articles where the members are long but compact in section. For broad surfaces they are never used, and for long-edge joints only when end grain meets side grain in which mortices can be cut; but, even then, they are rarely employed.

There are many varieties of mortise-and-tenon joint, but the differences are chiefly in the shape and proportion of the tenons in relation to the member they are formed on. There are first two important differences in the length of tenons. In one, the tenon, and consequently the mortise, cuts through the mortised piece, the end of the tenon usually being flush with the external face. In the other, the tenon only penetrates to a short distance, the mortise being correspondingly

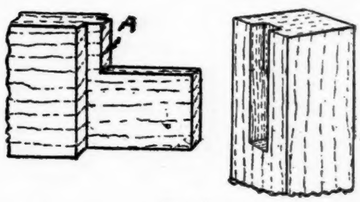


Fig. 2.

shallow. Both these forms are very commonly employed, the first being a through, or ordinary, tenon; the latter a stub, or stump, tenon. The through tenon makes a stronger joint, but there are a number of considerations which make the stub tenon quite as popular, even in work where strength is the first consideration.

The main function of the stub tenon in heavy work is usually not to hold the parts together, but to prevent their getting out of place laterally, the holding together being accomplished in some other way. In other cases, though not very often, a through tenon

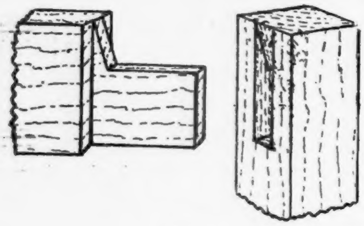


FIG. 3.

would be so long that a shorter one would hold equally well, or quite as well as necessity demanded. Another consideration is the weakening effect of a deep mortise, which diminishes the strength of the piece it is cut in.

In its simplest form an ordinary tenon is proportioned as in Fig. 1. It is made the full width of the

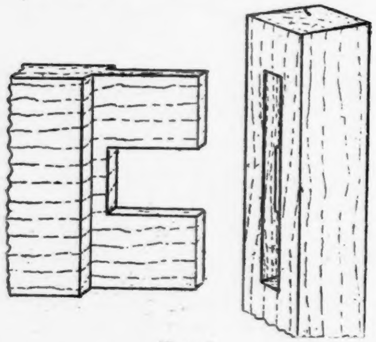


FIG. 4.

piece it is formed on, and of one-third the thickness. When the width exceeds five or six times the thickness, it is advisable either to reduce the width of the tenon, or to divide it into two parts. The former plan often

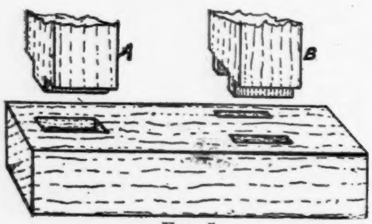


FIG. 5.

has to be adopted in cases like Fig. 2, where the mortise occurs at the extremity of the member, and it is desired to avoid cutting through the end grain. The tenon, then, even if well proportioned in itself, is reduced in width as shown, generally with a short stump called a haunch, A, but sometimes the cut-away portion extends completely to the shoulder. The advantage of the haunch is that it prevents warping or twisting of the members in relation to each other, as completely as if the tenon extended the full width. Fig.

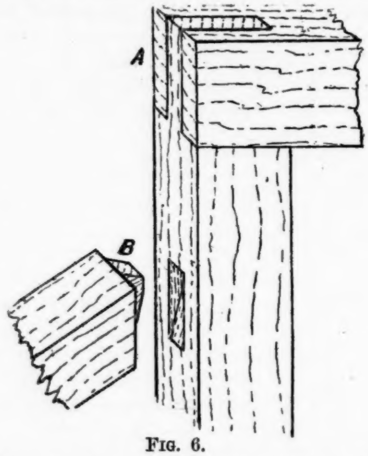


FIG. 6.

3 shows how the haunch may be tapered to nothing at the top, so that it will be invisible when the parts are together. This slightly reduces its efficiency. In Fig. 4 a pair of tenons are shown with a haunch between.

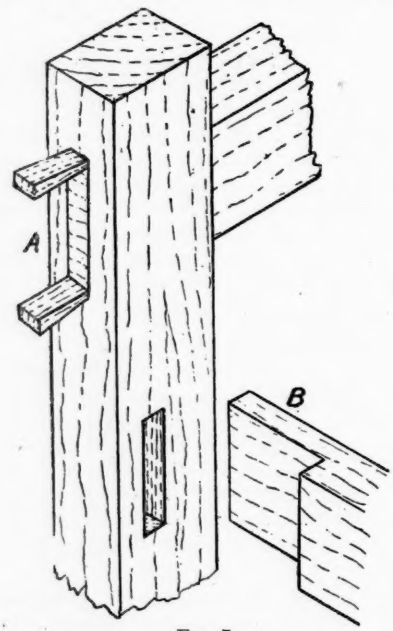


FIG. 7.

In this case the piece is so wide that a single tenon running completely across would be no stronger, and would be more likely to cause trouble through warping and shrinkage than when its middle part is removed

as shown. The mortised member, on the other hand, is decidedly stronger with the mortise divided than it would be with one long mortise for a single tenon. The opposite course might be adopted of having a single reduced tenon in the midle with haunches on each side, and circumstances sometimes necessitates this; but such a joint would not be so secure as one with a tenon at each end.

A stub tenon is shown in Fig. 5 at A. Its length depends on the proportions of the parts and on other circumstances; but it is seldom made to penetrate far.

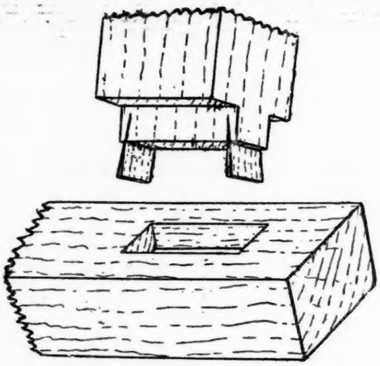


FIG. 8.

At B, Fig. 5, a double stub tenon is shown. These are employed to prevent twisting when the thickness of the parts is considerable. Being divided in this way, the mortised part is kept a great deal stronger than it would be if an equally effective single tenon was employed. A point to be remembered in cases of this kind is that the longer way of the mortise should always run with the grain of the wood. Double tenons, therefore, are often necessary, where, if only proportions had to be considered, a single tenon at right angles to the grain would be simpler.

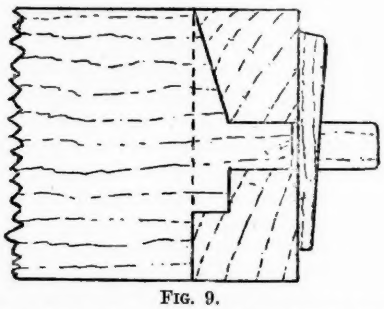


FIG. 9.

Fig. 6 A is a case where the tenon is not haunched, as in Fig. 2. It is not so often employed as the latter, and, of course, cannot be wedged, but must be screwed or pinned. It is more suitable for heavy work than for light; but in many cases a half-lap joint would be employed in preference to it. Fig. 6, B, shows a stub tenon for parts meeting at an angle. A through tenon in such cases is seldom employed. There are numerous other slight variations of the form of stub shown. Very often the tenoned timber is notched into the surface of the other as well as tenoned.

When mortise-and-tenon joints are not held together by external attachments, they are secured either by pins or wedges, and in joinery and small work are usually glued. In very light work glue alone is often relied on; but when this is not sufficient wedges are generally employed as well. Pins are better adapted for rough work, either with or without glue. Wedges hold the parts together by being driven either into, or alongside of the end grain of the tenon, making it club or dovetail shaped, the mortise being tapered to suit, so that the parts cannot be withdrawn while the wedges

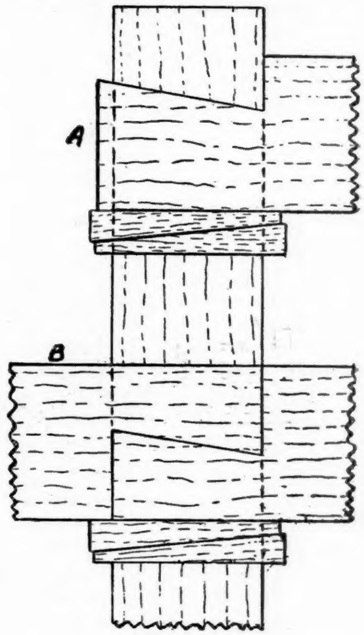


FIG. 10.

are in place. To make a secure point, therefore, glue should be used with wedges. In Fig. A, an ordinary joint is shown with wedges partly driven in. The mortise is cut slightly larger, and tapered to receive them, and the glue holds them to the tenon after they are driven. The ends, of course, are trimmed off flush in finishing the work. In cases where extra security is required the wedges are driven into saw-cuts in the tenon itself. Sometimes four wedges are inserted, but two is the usual number.

Fig. 7. B is a barefaced tenon. This differs from an ordinary tenon in being shouldered from one face only. It is employed chiefly for thin rails which have to be made flush on one side with the posts they are tenoned into.

Fig. 8 shows how a stub tenon is fox-wedged. The wedges in such a case cannot be inserted after the parts are together, and so they have to be forced home by the closing of the joint. Generally, however, stub tenons are not wedged. Fig. 8 also shows how the saw-cuts, both in stub and ordinary tenons, should be slightly out of parallel with the tenon, to lessen the risk of withdrawal.

When pins are employed for holding the joint, they are inserted from one face of the work, at right angles to the direction in which wedges are used. Screws or nails are often employed in this way, but more commonly wood pins or pegs, roughly pared to octogonal section, with a slight taper lengthwise, which are glued and driven into holes bored for them. Usually they do not go completely through the parts, but remain visible only from the face they are driven in at. When pins are used, they are made to assit in pulling the parts together by draw-boring; that is, by making small holes in the tenon slightly out of centre with the larger ones in the side of the mortise where the pins are entered. The work is usually cramped together before the pins are inserted, so that their function is not so much to pull the parts together as to maintain them so when the cramps are removed.

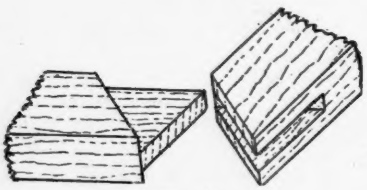


FIG. 11.

In some joints the end of the tenon is made to project considerably beyond the mortise, and a tapering pin is driven through the tenon only, as in Fig. 9. In such a case no glue is used, but the pin itself pulls and holds the joint together as tightly as may be required, and also permits it to be taken apart again by knocking the pin back. Fig. 9 is called a tusk tenon, and is employed for uniting heavy timbers which meet in a horizontal plane, the joint being designed specially to afford the maximum support to the tenoned end, with the minimum weakening of the mortised timber which supports it. As a beam is strained least in the central plane, it is only in that part that the tenon is allowed to pass through. Below the root of the tenon a short tusk is formed to prevent its geting sheared off, and it is similiarly strengthened above by a projection which tapers to nothing at the top, in order to cut as little as possible from the mortied beam. The weight of the tenoned timber is carried partly by the portion the tusk rests on, and partly by the longer support in which the slender tenon bears. In some cases, when the supporting beam is wide, or when timbers enter on both sides, the tenon is not carried through, but held by a pin inserted through a hole in the mortised timber. All the parts of a tusk tenon are of the same width as the timber they are formed on.

Fig. 10, A and B show dovetailed tenons held in place by folding wedges. In A, one timber only is tenoned into the post, which is usually thicker than the timber that enters it. In B two ends meet, entering the mortise from opposite sides. These joints are employed more for work which has to be taken apart than for fixtures. They are suitable when the timber in which the mortise is cut is thick, and the tenoned pieces thin. The latter, in fact, are generally not, strictly speaking, tenoned at all, but enter at their full thickness, and are dovetailed on one edge. Stub tenons also can be secured in this way.

Fig. 11 is an open mortise and tenon with shoulders mitred instead of square, like Fig. 6 A. It is, of course, not so strong as the latter, and is mitred for appearance. In cases where only one face shows, its strength is often increased by mitring the front only, and leaving the back shoulder square.

In large well-equipped shops, mortises and tenons are cut by machines. By hand, mortises are partly bored out with a bit, and finished to the lines with a mortise chisel, or they are cut by chisel and mallet alone. Tenons are sometimes sawn to the line, but more frequently their shoulders are finished with a chisel, and their faces with a rebate-plane. Scribed and guaged lines are used everywhere in preference to pencil. The thicknesses of tenon and mortise are gauged with a mortise-gauge, which markes both lines simultaneously. The shoulders of the tenon and ends of the mortise are marked with square and scribe. If the tenon is a through one, it should be long enough to allow for dressing off after it is in place. A stub tenon should be a trifle short in its mortise to insure a close fit at the shoulder. The latter should be slightly undercut to insure close contact at the exterior.

THE ORIGIN OF PEARLS.

Many suggestions have been made as to the origin of pearls. According to one theory, pearls arise from secretions caused by the presence of some foreign object, such as a grain of sand, within the shell of the oyster. But it has been shown that fine pearls are not thus produced, but only pearly concretions. Another theory is that pearls are the result of disease in the oyster. M. Seurat of the Oceanogaphic Museum of Monarco, believes that the origin of pearls is to be ascribed to the presence of a parasite. The species of parasite differs with the species of oyster, but this mode of origin is general with all fine pearls. To restore the luster of a "dead" pearl the outer tarnished envelopes may be removed by acids. Thus the effect produced upon a tarnished pearl by causing a fowl to swallow it is accounted for by the dissolvent action of the gastic juice.

SOME NEW IDEAS AS TO EXPOSURE AND DEVELOPMENT.

WALTER ZIMMERMAN.

Beginning with the successful result of the theory that like development produces like results in the making of negatives, a theory upon which the writer has worked for some years and which has been put into practice by the tank developing machines, there are many things which are new to the photographer who still adheres to the old methods. It is useless to enlarge upon the uniformity of tank development except to say that special attention to each individual negative is usually labor wasted.

The man who wants the same class of negatives every time, has only to get the right developer, one to suit his plate or film, and then find the time of development for either, as the case may be, and save his time for other things while the developer is producing better results than if the negatives were being handled and watched.

There is, however, a long step beyond all of this. The photographer, amateur or professional, may obtain any effect that he may desire from pactically any one kind of photographic surface by thoroughly grasping the higher principles of exposure and development. This may seem to apply a contradiction to the former theory; on the contrary, by true development each operator obtains or may obtain just what suits his particular purpose and each will obtain individual results by his individuality of method as manifested in exposure, strength of developer and duration of development. This then brings us to the newer theory concerning which I am now writing.

In negative making let us observe first, what different effects would be wanted by different workers or by one photographer for different purposes. For instance, by A, a very thin negative full of detail for "soft," "low-tone" printing. By B, a negative giving strong effects and printing great contrasts in lights and shadows. By C, and by the great majority, a negative with good detail and with sufficient variety as to light and shadows. By D, a negative in three tones, light, dark and middle, with elimination of detail. We will say that A works for low tones for exhibition purposes and is strictly non-commercial. B is an amateur whose ideas of beauty in photography is the strength of the negative and the contrast in the print. C is a commercial photographer or an all-round amateur who does not reach after impressionism. D is an exhibition photographer, an impressionist at the other end of the scale from A and may be A himself working on totally different lines as if frequently shown in a collection of one man's work producing both "low-tones" and "poster" effects.

Many readers will say that but one result can be obtained with one particular plate and one paticular developer. The man who so believes may want to read this article; the man who can successfully produce the four effects from one plate and one developer may not. The former will probably say that for four kinds of results he must use four kinds of plates and four kinds of developers. He shows his advancement by being able to obtain these varied results by any means whatever; but he will show still greater advancement by being able to obtain all with a single set of tools instead of four. The "easy" way to get the four effects is thus: For A's negatives, a fast plate usually, instantaneous orthochromatic, over-exposure and weak developer, such as dilute metol. For B's negatives, a slow plate, just sufficiently exposed, and strongly developed. For C's negatives, a fast or medium fast plate with full, not over, exposure and medium development with strong metol-hydroquinone or pyro. For D's negatives, a slow plate decidedly underexposed and greatly over-developed, such as with hydroquinone. It will be something, at least, for many of our readers to know how these very different results may be obtained, even if, as I say, by different sets of tools.

Now to work on the practice of our advanced theory; we have several kinds of plates giving, as is supposed, as many different effects in negative making. They are generally the 1st, extra rapid; 2nd, extra rapid orthochromatic; 3rd, medium fast; 4th, the slow; 5th, the very slow, and, 6th, the double-coated fast plate. Illustrations of these six general classes of dry plates are:

1st. Cramer's Crown, Seed's 27, etc.
2nd. Cramer's Instantaneous Isochromatic, Seed's Rapid Orthochromatic.
3rd. Cramer's Anchor, Seed's 23.
4th. Cramer's Contrast.
5th. Seed's Process.
6th. Seeed's Non-Halation and Standard Orthonon.

Can the theory be made to apply successfully to these six classes of plates? The relative exposure required to produce the usual average results with each are as follows: Nos. 1 and 2, one; No. 3, three; No. 4, six; No. 5, ten and No. 6, one and one-half. After learning the average exposure of each of these varieties we can proceed to work out our theory. The non-halation plates are placed last in the list for the reason that with strong development they give even greater contrasts than classes 4 and 5.

Let us suppose the No. 1 class as being the only kind of dry plates that the worker has on hand and the stock solution of metol-hydroquinone is the one developer. The formula is as follows:

Water, nearly hot	4 ounces.
Metol	1/2 ounce.
Sulphite, dry	4 ounces.
Hydroquinone	1/2 ounce.
Carbonate, dry	6 ounces.

For ordinary use dilute with equal quantity of water. To produce A's effects: over-expose the plate, make developer one-fifth average (with stock solution, one part to ten of water), and give three or four times, instead of ten to twenty times, period of development with usual solution. Use no bromide. To produce B's effects: expose barely enough for shadows and use normal developer, full development. Use slight excess of bromide. To produce C's effects: give correct exposure for shadows and normal developer and development, normal use of bromide. Further modifications may be made in the use of intensifiers and reducers; ferricyanide-hypo intensified increasing while the persulphate-ammonia diminishes contrasts and any intensifier increasing contrasts. The whole theory as to development stands largely upon the axiom that strong development exaggerates contrasts and that weak development diminishes it.

Now go to the other extreme and to obtain the four kinds of effects from the slow or very slow plate. Plate clases 4 and 5; the difficulty seems greater, and to many the thing will seem to be imposible, but we will proceed. First of all one must learn the requisite exposure of the slow plate emulsion to be used, in order to obtain full and complete detail in all shadows regardless of what may happen to the parts of the negative representing the high lights. There are very few who know how to give full exposure for slow plates. With this knowledge work in this way: For A's effects, give at least five times the exposure for complete detail in the shadows and develop with a developer diluted with twenty times the normal amount of water, no bromide. For the stock solution given herein use forty parts of water. Ordinarily, the slow plate develops much more rapidly than the last one. For A's negatives with twenty times diluted developer give ten times usual development with normal developer.

Right here should be given the caution that in using very dilute developer, the development should be by tank or with very deep trays filled to the brim in order to have a sufficient quality of the chemicals to produce the necessary results. For B's effects with a slow plate, give nearly full exposure to shadows and use normal developer. This kind of plate is ideal for B's results. Use a little bromide. For C's effects, that is, to obtain the usual "good" negative, slightly over-expose for shadows, make developer one-fifth usual strength and give five times usual period of development, omitting bromide. For D's effects, use the slow plate which is ideal for poster work. Expose for high lights and use normal developer, with bromide. Of course the average or medium plate, class 3, is for the average work and to this class our theory is particularly applicable as obtaining the greater variety with greater ease. Exposing for shadows should be learned as with the slow plate.

For A's effects with class 3 plates, expose several times over that for shadows and weaken developer to one-tenth; under-develop and use no bromide. For B's effects: expose for shadows and use normal developer with some bromide. For C's effects: expose for shadows and use developer one-half normal and no bromide. For D's effects: expose for high lights, use normal developer with bromide and full development.

The things which the writer, as well as the reader, has to contend with in learning the means of working on this interesting theory are, the lack of exact knowledge on the part of far more than nine-tenths of the bulb-squeezers and button pushers. Please, reader, do not feel offended, as this cannot posibly mean you, as to two or three important points referred to, for instance: "normal development," "exposure for shadows," and the correct use of bromide of potash, so that a brief reminder on these points will be useful. Normal development means such development of a properly expressed plate as will give correct definition in the lights and the darker parts of the resulting print. Exposing for shadows means disregarding the effects of the strong lights and exposing for the poorly lighted colored parts of the view or subject. The correct use of bromide is that which will avoid the darkening of the unexpected film by the chemicals.

I writing technical articles of this kind, one need lay aside personal ideas as to his individual methods and treats only of the general idea of getting every thing in the negative. An article of this kind is meant to show what an average worker does in order to produce a given effect, nevertheless the four general effects here described will cover fairly well those sought for and obtained by the photographic workers of all schools and classes; for instance, A, illustrates the "low-tone" impressionist; B, the very new amateur; C, the average "good" photographer, and D, the "broad" impressionist.

In order to obtain good results from the working out of this theory the photographer should ignore a third theory; that of factoral development. It is a theory that will not work in all-round practice. The factoral theory is, this: multiply the time of the appearing of the image by the factoral ratio of the developer. The theory answers very well with a normally exposed plate but it is the most fallacious when applied either to the over-exposed or under-exposed plate. Let readers who like to experiment try for themselves, follow

instructions and observe results. The treatment for the best negative from an under-exposed plate is prolonged development with rather weak developer, the tray and plate being, of course, covered to exclude even red light, and the tray rocked ocasionally. The best results from an over-exposed plate are obtained by considerable over-developing and afterwards reducing to the proper printing density. Hundreds of over-exposed negatives are thrown away by failure to know or act upon this simple rule which is in flat contradiction of that of fractoral development.

Laying aside the subject of producing varied effects from one form of dry plate and with one developer, there can be great variety in the effect of the photographic print acording to the printing paper employed. For illustration: To print for softness and full detail, use a printing out or toning paper, and for richness of tone, as well as fair detail, use platinum paper. While these facts are interesting and useful, they are also well known to the advanced amateur or professional.

Let us now continue the illustration of our theory by showing how varied effects can be obtained from any one printing medium and with any one reducing agent or developer. The quick thinking reader will probably have already foreseen part of that which may be said on the subject, as the result of the description of the methods for working dry plates just given. Taking the printing mediums in the order in which I have named them, the printing out or toning paper has the least possible elasticity in the methods of working it. Some small modification can be made, even here, for the contrast may be increased by over-printing and then using toning and fixing baths made to "cut" the print, or else by having the toning and fixing considerably prolonged in action. The "Regular" Velox is next in its resistance to variety in printing effects but a considerable over-exposure and an inversely weakened developer with omission of bromide will produce flatness or softness with detail while the usual exposure and development tends to strong contrasts with this paper. The several grades, however, give a wide variety of results. Bromide paper is very much more like the dry plate in producing varied effects for the same negative in contact work, the rules briefly being as follows: To produce a soft detailed print from a dense, harsh negative, the worker should know, to begin with, that the proper or normal printing distance for contract work with bromide paper is five or six feet from the printing light. To produce softness and detail from a harsh negative, hold the printing frame one foot from the printing light and give double normal exposure using weak developer without bromide. Suppose that normal exposure five feet distance were twenty-five seconds, normal exposure at one foot would be one second, double exposure two seconds. The experiment is most interesting.

To produce contrast, print from a weak negative using bromide paper, supposedly a difficult thing to do, one may cut down the light to say one twenty-fifth or better, make the exposure at five times the normal distance; that will be twenty-five feet and the normal exposure will be twenty-five times that at five feet, in order to obtain the same depth of printing. Under-exposure, say fifteen times instead of twenty-five times that at five feet, and use strong developer with some excess of bromide.

To produce alternately, soft and hard results from the same negative, follow first the rules for the over-exposure at one foot and then those for the under-exposure at twenty-five feet, bearing in mind that the proportionate normal exposure at the two distances is as one to six hundred and twenty-five or as one second for one distance and ten minutes and a quarter for the other. The reader may know all of this but a reminder may save him good printing paper.

Singularly enough, platinum paper is capable of greatly increased or diminished contrast but this discovery was fully treated in my article on the subject which appeared in this magazine two or three years ago. Those who have read it will recall that to obtain great contrast the paper was to be over printed until the image should be reversed, development being by cold water only. For contrast and detail, print until the paper is almost uniformly darkened prior to reversal and develop with hot water. For softness from harsh negatives, print nearly to normal and use saturated developer, nearly boiling. I give this repetition very briefly for the reason that former issues (I won't say back numbers, for Camera Craft never is a "back number"), are unobtainable, having been destroyed in the great San Fransico fire. It is at the urgent request for "copy" on the part of my good friend the Editor, who has had his full share in the heavy losses from the fire, that I have very hastily prepared this treatise on a subject which ought to be a very interesting one.—Camera Craft.

VAPOR LAMP GIVING WHITE LIGHT.

The mercury vapor light, developed by American inventors, which in the form of long, glowing tubes, produces more light at less cost than any other practical method of illumination, and would be extensively used if it were not for the color of the light. It is strongest in the violet end of the spectrum, extending far beyond the limits of visibility in that direction and including an abundance of rays that can be photographed but not seen with the naked eye. This mercury glow light has made the "while you wait photography" of the pleasure parks a possibility, but it is too ghastly for common use. But recently German chemists have overcome this difficulty by putting into the electrodes other metals besides mercury, thus changing the character of the light. Zinc with 10 per cent of bismuth and a trace of sodium is used for this purpose.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

III. Setting up the Frames and Planking.

After the moulds are all correctly set and the ribbands fastened, the form is ready to receive the frames. These frames are of oak 1 in. x 1½ in., and are spaced 9 in. apart, center to center. This brings three frames between each two moulds, with another bent in to take the place of the mould when the latter is removed. The positions of the frames are marked off on the bottom, and also on the top ribband to guide in bending them in evenly. The frames should be of rather green stock, as thoroughly dry stock is two brittle to bend readily. It is, in fact, many times advisable to obtain a fresh green stick and have it ripped up at the mill to the proper size. This green stock bends very readily and after it seasons in place there is no tendency to change shape.

In building a boat of this size, a steam box is very desirable, as there are many pieces which will require steaming to render them pliable. It should be about 12 ft. long and 10 or 12 in. square; it may be built of rough boards, but should be fairly tight. One end is closed and the other has a door. It should be placed in a convenient position and steam led to it from a wash boiler or teakettle, which may be heated by any convenient means, such as an oil stove.

A number of frames can be steamed at once, they being drawn out as required. The frames should be steamed until they are heated all through and very limber. A frame is then taken out and bent partially to shape over some convenient forms, such as a stiff barrell or similar shape. It is then put into the proper place in the form and bent out until it bears evenly against all of the ribbands; it is then clamped solid in place. Care must be taken to bend the frames quite sharply at the point where they leave the flat of the bottom, to take up the curve of the sides. A monkey wrench clamped on to the frame is sometimes used to obtain a sharp bend; one must, however, use care not to break the frame and destroy its strength. The frames extend to the center line of the bottom and may be fastened at once by two or more galvanized nails driven through it into the bottom.

The timbering may be begun at any desired point, but should continue equally on each side of the boat. As soon as each frame has cooled somewhat, the clamps may be removed for further use, and the frame held in place by pieces of wire wound around both frame and ribband, or in any other way which may be convenient. Very little fastening is necessary after the frame has "set." The top of the frames should be allowed to extend above the upper ribband a foot or more; a rope is then passed around the tops of the opposite frames and the tops drawn together somewhat to assure that the frames will not have too great an outward slope.

At the ends of the boat the frames will have a considerable amount of twist, and instead of following a square up the side, will tend to slope more towards the ends, giving them a sort of radiating appearance. There is no particular harm in this, and it makes the bending much easier. Abreast of the center board slot the frames should be kept clear the same as were the bottom cleats.

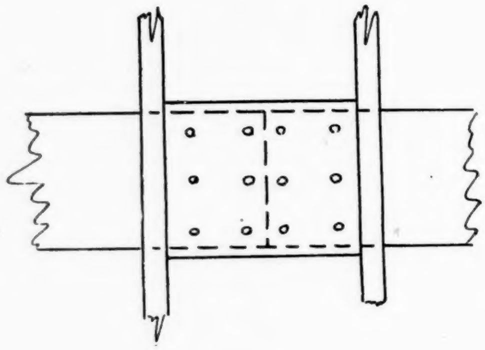


FIG. 17.

It is desirable that the frames be finished somewhat before putting in as there are certain places where they will show. Those between molds 2 and 5 especially should be quite well finished and the inside covers bevelled, as they come in the cabin and will show if the latter is not ceiled.

When the above work is done the frames should all be fair and touch all of the ribbands evenly; any small irregularities will of course work out during tne planking, but any great unfairness may be removed by giving the frame an additional bend.

Stock for the planking should be 7/8 in. thick, and of cedar, pine, cypress or hard pine. The two former are the lightest, but cannot now be obtained generally in long lengths nor in wide boards owing to their scarcity. Cypress has lately come into use for boat building; it can be obtained in almost any length or width and is on the whole a very satisfactory material for planking. Hard pine is rather heavy, but is extremely strong and durable and easily obtainable. It is, however, harder to work than any of the others.

The kind of stock used must in any case depend upon the locality and what is obtainable; other things being equal, however, the writer would recommend cypress. Whatever stock is used should be gotten in lengths of about 15 ft. so that each plank will have no more than one butt or joint in it; the widths also should run from 8 to 12 in.

A little consideration and inspection of the form of the boat will render the work of planking much easier. A thin batten 3 1/2 in. wide, 1/2 in. thick and about 15 ft. long, and as near straight as possible, should be gotten out for future use. If this batten is laid up against the bottom of the boat about 4 in. from the rabbit, it will be noted that the straight line of its edge does not follow the rabbit in the bottom, but lands well up on the stem and stern board. The same effect will be noted if the batten is bent around the bilge. It is thus seen that the edges of the plank cannot be straight, but must have a curvature in order to bring the ends down to a reasonable height. It is for this reason that the stock for planking must be so much wider than the actual plank. The garboard, or plank next to the bottom, is the first to be fitted. Undoubtedly the garboard is the most difficult plank to fit and must be done first. Following out the above principle the garboard will be made narrow amidship and as wide as possible at the ends, so that the planks above will not have an excessive amount of curvature. The width amidships should be about 4 in. and at the ends about 12 in.

Perhaps the best way to fit this garboard will be to make a pattern from a piece of 1/4 in. stock. The forward and aft ends should be fitted separately. The 1/4 in. piece may be easily bent around and fitted by trial. It must fit nicely into the rabbit of bottom and stem at every point. When each portion of the pattern has been fitted they should be tacked in place, and the upper edges trimmed down until they join in an even, smooth curve. The pattern is now laid on the board, marked around and the shape cut out, one of each for each side. The plank itself must now be fitted by trial, but only a small amount of trimming should be necessary. To hold the plank in position, clamps may be hooked around the moulds, and shores may also be wedged between the plank and the floor. Care must be taken not to split the plank; a piece of board must always be placed under the end of a shore or clamp screw. When the two portions of the plank have been fitted they should be clamped in place and the over-lapping ends cut off just even and half way between two frames.

The fastenings of the plank to the frames may be one of three kinds, copper nails riveted over burrs or washers inside the frames, galvanized iron nails, or brass screws. The first is the most expensive, and the most work, but in the long run is probably the best. The second is the cheapest and perhaps the most common method. When carefully done so as not to split the frames in the proces it is a good fastening. The nails must, however, be clinched, merely driving them into the frames is not sufficient on such light work as

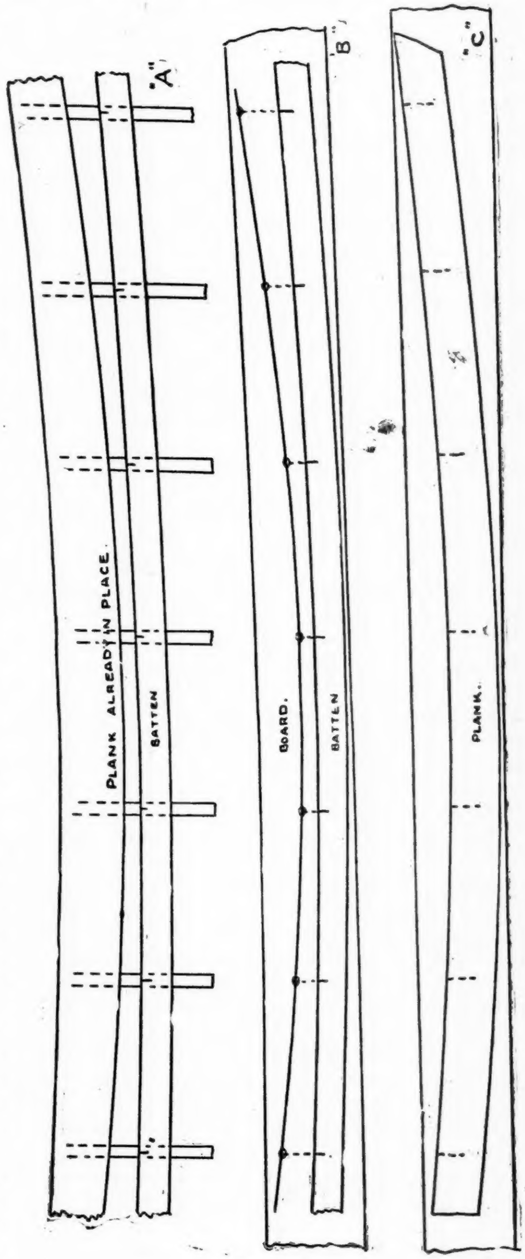


FIG. 18.

a small boat. The third method is a very good one if screws of sufficiently large wire are used. If the

screws are too small the shrinking and swelling of the wood will break them off and destroy the fastenings. The writer is inclined for the present purpose, to recommend the galvanized nails. They should be the chisel pointed boat nails 2 in. long. A hole must be bored for each of such a size that the nail requires only a moderate amount of driving to set it up into place. The nails are driven with their points parallel with the grain of the frame, so as to clinch easily. They are driven so that their heads are sunk just below the surface of the plank, and the point clinched across the grain of the timber. To prevent the nail from backing out during the clinching, a heavy, pointed piece of iron, such as the head of a top-maul is held against the head; this allows the nail to be solidly clinched and the plank drawn up solid on to the frame.

If copper fastening is used, the nails should be of such a length as to project about 3/8 in. inside the frame, a copper burr, or washer is then driven on, the point is cut off about 1/8 in. outside of the washer, and headed down, the iron being held against the head.

If brass screws are used they should be about 3/8 in. diameter under the head and 1 1/2 in. long. Two boardings must be made, one through the plank, of the size of the body and another in the frame of the size at the bottom of the thread. The screw should be smeared with soap or grease before driving, and a bit brace with a screw driver bit used to set them up. Fastening by this method can be very quickly done.

The garboard can now be fastened in place in the manner chosen. Fastenings should be placed about ¾ in. from the edge of the plank, and should be spaced about 3 in. apart. A row of fastenings is also driven through the garboard into the overhanging rabbet of the bottom. These are about 4 in. apart and are driven carefully so as not to split either the garboard or the rabbet.

The joint between the two portions of the plank is now to be covered by a butt-block of hard wood, fastened over the joint on the inside, between the frames. This butt block should fill the space from frame to frame, as in Fig. 17, and be about 1/8 in. wider than the plank. Fastenings are then driven through the ends of the plank into the butt-block. The ends of the plank at stem and stern are fastened with either nails or screws.

The distance around the mould No. 4 from the upper edge of the garboard to the sheer line on No. 4 mould should now be divided into equal spaces of about 6 in. each. The distance on each of the other moulds is divided into the same number of equal parts, the length, of course, decreasing towards the ends. These lines are for use in fitting the other planks, to give an equal taper to all.

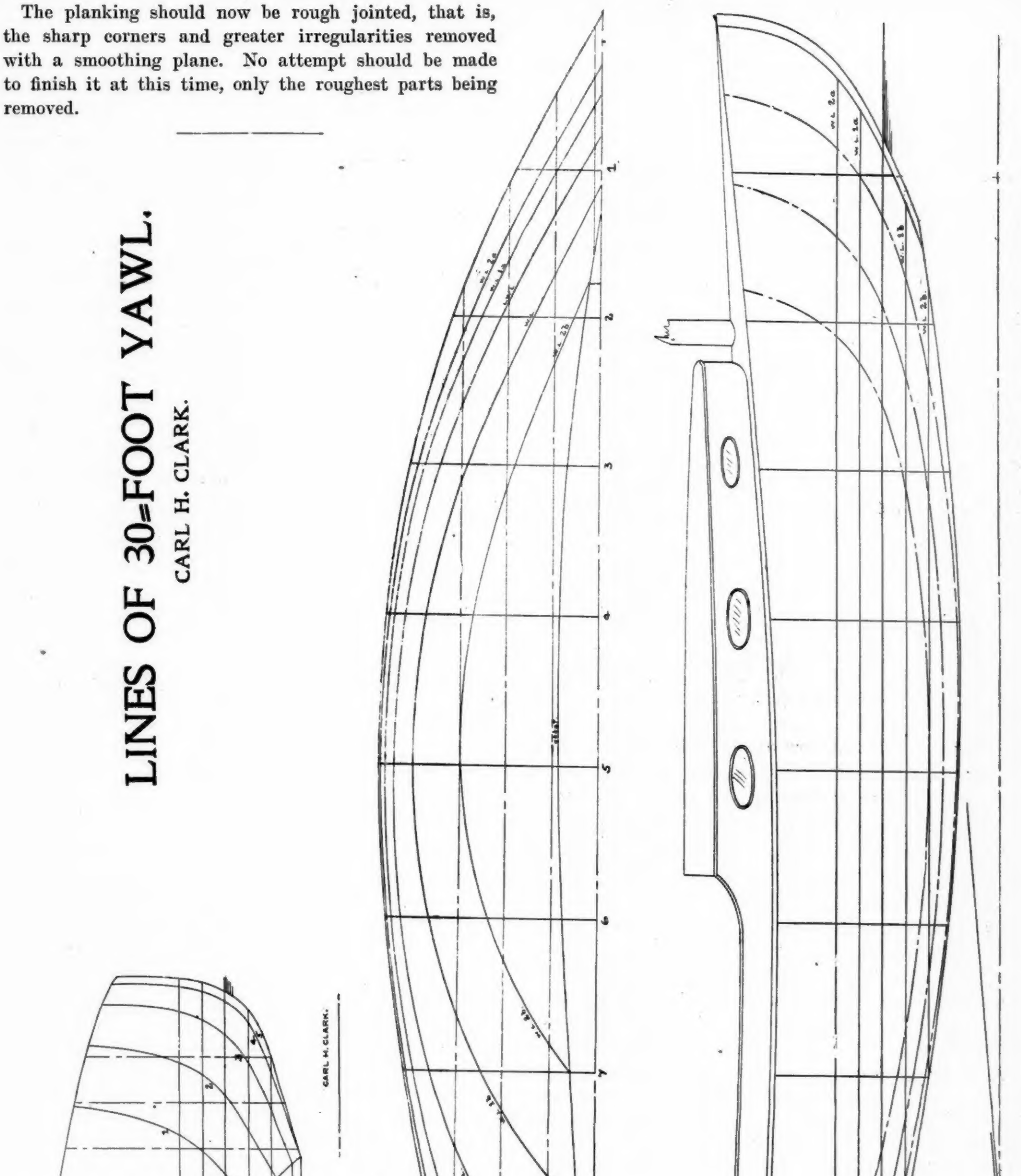
To fit the next plank a "spiling" must be taken, using the thin wide batten before described. The batten is clamped around the frames about 1 in. from the edge of the garboard and allowed to take its own natural curve without any forcing sidewise. The batten will diverge from the edge of the strake in a gradual curve.

Referring to Fig. 18, cut *A* shows a view looking up at the bottom, showing the plank already in place, the batten and the frames. The distances from the edge of the batten to the edge of garboard at each frame are measured and recorded, the centre of each frame is also marked in chalk on the batten. The batten is then transferred to the board from which the plank is to be cut, as in cut *B*. The distances just taken are then laid off from the edge of the batten at the proper point, giving the points on the curve as shown. This is the outline of the lower edge of the plank. The widths of the plank are then measured on each mould and laid off as in cut *C*, giving the upper edge of the plank. The plank is then cut out and fitted in place on the boat. The butt on this plank should not be placed over that in the garboard, but should be shifted about three feet away. The plank when cut out will require a certain amount of fitting, which is done by trial. Before fastening into place a duplicate should be marked out for the other side. When fitted, the plank may be fastened in place as already described. Planking should be continued up around the turn of the bilge, removing the ribbands as necessary. The top streak should now be fitted, great care being observed to have a good sheer line. The remainder of the plank are then fitted successively one below the other until the space is closed up. All the joints should be as close as possible and each plank should be forced down against the preceding one as firmly as possible. In order to make room for the calking each edge of the plank should be beveled slightly so that, while the planks are close together on the inside, they are about 1/16 in. open on the outside. The planks around the bilge will probably need to be hollowed slightly on the inside to get sufficient curvature without splitting the plank. Each plank should be fastened into place before fitting the next one. There are many schemes and devices which cannot here be described, but which will occur to the builder as the work proceeds. Numerous clamps are a necessity in planking and a very handy device consists of a chain passing down to the foundation, with a crew clamp for forcing the plank down against its neighbor. The various butts in the planks should be distributed as widely as possible and those in corresponding planks should be in the same position.

The projecting ends of the planks at the stern may now be trimmed off even with the stern board.

Several braces should be fastened across the top of the boat from frame to frame to prevent it from spreading and the mould may now be removed. If any change of shape is noticed upon the removal of the moulds, braces should at once be fitted to restore it. When the moulds have been removed, frames are to be bent in in their places and fastened.

The planking should now be rough jointed, that is, the sharp corners and greater irregularities removed with a smoothing plane. No attempt should be made to finish it at this time, only the roughest parts being removed.



LINES OF 30-FOOT YAWL.

CARL H. CLARK.

BOOKS RECEIVED.

MODERN MILLING MACHINES. Joseph G. Horner, M. E., 304 pp. 8 3/4x5 1/2 in. 269 Illustrations. Cloth, $4.00. The Norman W. Henley Pub. Co., New York.

Anyone at all familiar with the books previously written by the same author, expects much of any new one which may be announced. This one is no exception to the clearness, accuracy and attention to detail which characterizes all his writings, and the mechanic, foreman and superintendent, as well as the technical instructor, will obtain much valuable information from it.

In the present day specialization of manufacturing processes and the wide variety of work possible to certain twpes of machines, separate treatises are necessary to adequately treat them. This is particularly true of the milling machine, and the advent of this book is most opportune. As a guide to the correct and best methods of handling work it is invaluable, that of a character requiring special skill being given special attention.

The illustrations are numerous and many of them are fully detailed drawings reduced from workshop prints; the matter of obtaining speeds and feeds having received careful attention.

It is most certainly a book for every library making any pretentions towards supplying the needs of the technical reader.

PUNCHES, DIES AND TOOLS, for Manufacturing in Presses. Joseph V. Wodworth, M. E. 483 pp. 9x5 3/4 in. 702 Lllustrations. Cloth, $4.00. The Norman W. Henley Pub. Co., New York.

This book, like the one above mentioned, is devoted to a special class of metal work, and gives, therefore, a mass of detail and practical information of the greatest value to those engaged in that special line of manufacturing. It is somewhat of a companion volume to "Dies, Their Construction and Use," by the same author, but treats the subject in a broader and more comprehensive manner, containing much matter not covered in the previous volume.

A large number of valuable and interesting processes, rules, formulas and designs have been embodied in the work, making it of inestimable value in connection with the construction, use and adaptation of dies and presses tools which form the subject matter of the books.

So much in the way of sheet metal working can be and is done today in prcsses that anyone in charge of a shop where such work is done must be alive to all the kinks of the work, and this work will be of great value to all such. Instructors in advanced technical schools cannot well do without it; the larger technical libraries should have it on their shelves.

ALCOHOL FROM CORNSTALKS.

The Department of Agriculture is developing a new industry in the production of alcohol from corncobs, which, the department says, promises to be of much commercial value. Investigations are being made at Hoopeston, Ill., and have proved that the large quantities of corncobs which every year go to waste can be made to produce alcohol in sufficient qualities to justify the erection of a distilling plant in connection with a corn cannery.

So far the department has succeeded by simple methods of fermentation in getting a yield of 11 gallons of alcohol from a ton of green cobs, and, by similar methods, in getting 6 gallons of alcohol from a ton of green cornstalks. A department official says that these tests show that there are 240 pounds of fermentable substance in a ton of green field cornstalks, which will yield about half of their weight in absolute alcohol. In round numbers, a ton of stalks will produce 100 pounds of alcohol or 200 pounds of proof spirits. As a gallon of alcohol weighs nearly 7 pounds, there should be 15 gallons of alcohol in a ton of stalks. The addition of the corn on the cob adds further to the possibilities of alcohol obtainable from a ton of cobs, and will have its influence in bringing the quantity to a greater figure.

AMBER IN SANTO DOMINGO.

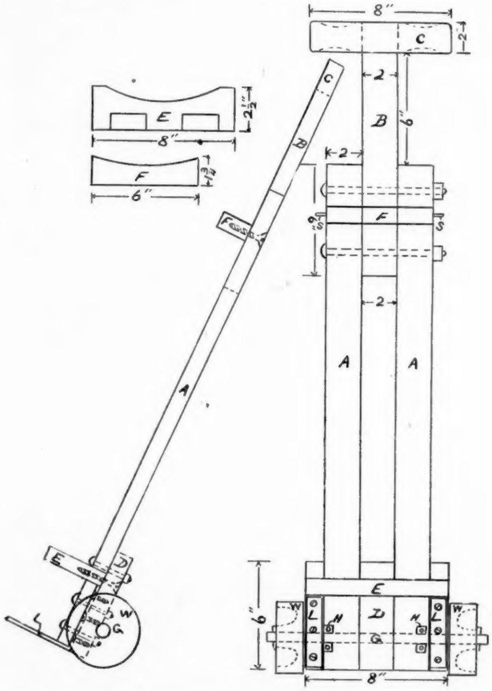
Santo Domingo is one of the few places in the world where amber occurs in any quantity. The bulk of the supply comes from the vicinity of Konigsberg, on the Baltic seacoast. There it occurs in the lower oligocene, and appears to have been deposited originally in glauconitic beds of clay, which was afterward eroded by wave action and the amber distributed, though much of it is taken from beds in which it was originally deposited. Amber is simply fossilized rosin, derived apparently from certain coniferous trees. The conditions under which it occurs in Santo Domingo do not appear to differ substantially from the Baltic seacoast. It is found near Santiago city, associated with lignite, sandstones and conglomerates. These beds probably belong to the oligocene formation and are found containing amber at a number of places on the north coast, as well as on both flanks of the Monte Cisti range. It also frequently occurs in the streams flowing through these beds. The amber is usually in ovate lumps, from the size of a pea to a man's fist, often flattened, dull on the exterior, being covered with a kind of brownish crust.

Distillation is the only process to obtain absolutely pure water. In the United States navy water aerated during distillation and run through a bone black filter for the purpose of improving its taste is exclusively used for drinking purposes.

ASH BARREL TRUCK.

WILBUR S. CHANDLER.

The periodical wrestle with the ash barrels that falls to the lot of city residents, where weekly collections by the official wagon necessitate regular attention to this dusty work, make any device welcome which will lessen the trouble and dirt. The simple truck here described is easily made, the materials costing but a small sum, and with it large barrels full of ashes may be removed from any cellar, the exit of which will allow of portable ways made of two boards held together with a few cleats, and spaced to allow the truck wheels to run thereon.



The general dimensions and design are clearly shown in the drawings. The framework is made of any straight grained hard wood, preferably oak; although birch, maple or white ash will be quite suitable. First make the arms consisting of the pieces A, B and C, using stock 1 1/2 in. thick, and nicely planed all over. Then fasten the piece D, using 1/2 in. bolts 2 or 2 1/4 in. long, and boring holes of close fit. The handle C should be carefully mortised to B, and may be cut out to give a beter grasp to the hands. The wheels are next to be considered. Two 4 in. heavy scale wheels were used for this truck, the same being obtained from a scale agency at a cost of 40 cents. The axle, 11/16 in. diameter, is 12 1/2 in. long. A piece of cold rolled shafting was used, and it was necessary to take it to a machine shop and have two 1/8 in. holes drilled in it, each a scant 3/4 in. from the end. These holes are for the pins holding the wheels in place. The axle is attached to the back of the piece D with U bolts, but if these are not obtainable, a groove can be cut in a piece of board and fastened to D with several screws. If scale wheels are not to be had, wooden ones cut from 2 in. oak plank can be made, and bushed with brass or steel tubings will answer nearly as well.

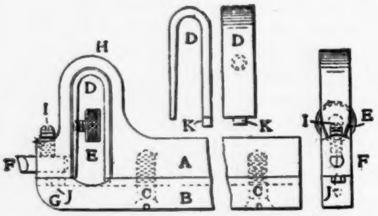
Two 4 in. heavy angle irons L are then firmly attached with screws, the projecting ends serving to take up and hold the barrel. The pieces E and F are curved on the upper sides, and provide a rest for the barrel, preventing it from rolling off to one side when passing uneven places. They are attached to the pieces A with long screws. Countersink the heads of all screws. One end of a piece of long link dog chain 5 1/2 ft. long is fastened with a staple S to the left end of the piece F, and another staple driven out the right end. After the truck has taken up the barrel, this chain is carried around it, and the nearest link placed over the staple, a heavy wire nail or other pin holding it. This pin is attached with cord to the end of the right piece A. A coat of varnish or paint makes the truck easier to keep clean. In addition to its use for ash barrels, flour and apple barrels are frequently handled.

Pewter has been used in most countries of the Old World for the last 2000 years. It was the substitute for silver and was to be found upon the tables of the well-to-do classes of the Middle Ages. Later it took the place of "treene"—wooden dishes, platters and bowls—in the homes of the peasantry and it was in general use until superseded through the adoption of cheaper materials, china, earthenware and Britannia metal. Like silver fine pewter oxidizes slowly, and unlike those of copper or brass, its oxides are harmless. Tim forms the greater part of pewter, the finest varieties, sometimes called "tin and temper," being simply hardened by a small portion of copper. Ordinary pewter is a mixture of tin and lead. The law of France restricts the content of the lead to 16.5 per cent.,this mixture being claimed as proof against sour wine and vinegar. Britannia metal is really a pewter of good quality, containing tin, antimony and copper.

SPRING THREADING TOOL.

Mr. A. B. French, in the "American Machinist," gives the following information regarding a spring threading tool:

The drawings show a special spring threading tool that gives satisfaction and produces nice smooth threads. The body of the tool is in two pieces A and B, both made of tool steel. The bottom B is of 1/4-inch square stock and has a 1/4x1/8-inch slot in it as shown. The top A is made of 1/2x3/4-inch stock and has a 1/4x1/8-inch tongue, a nice fit in the slot in B. A and B are held together by the screws C.



The front end of the body at G is hardened. The tongue and slot are ground and lapped and should be a nice sliding fit. The neck of the tool H is about 3/16-inch thick, the space for the spring is 3/4x1 5/8-inches. The spring is made of spring steel, tempered. On the bottom of the spring there is a tongue K to fit into the slot in the body B. The adjusting screw E is 1/4-inch, 20 threads, it is to adjust the tension of the spring. The thread tool F is made of 1/4-inch Stubs steel flatted on the top. It is held by the set screw I, the hole in the body not being drilled quite through so as to back the tool up. The small pin J is 1/8-inch diameter driven into the lower half of the body B; in the upper half A there is an elongated slot 1/8x3/16-inch for it to work in.

This tool is not designed for heavy work; the largest I have ever used it on was a 1-inch 8-thread tap.

By adjusting the screw E you can get any tension on the spring you want to suit the size of thread being cut. As the nose of the tool is supported the tool cannot spring downward or to the side; when it strikes a hard spot it springs back.

SCIENCE AND INDUSTRY.

A knowledge of geology is indispensible to the complete education of the miner, the prospector, the civil engineer, and the military engineer, and a first hand acquaintance with at least its elements is eminently desirable for the agriculturalist, the geographer, the traveler, and the biologist. Many may even be willing to admit that the literary man and the man of culture would be the better for knowing something of its principles and its conclusions.

Among the numerous uses for charcoal are, as a fuel, polishing powder, in blowpipe work, in filters, as a defecator and decolorizer of liquids, an absorbent of gases and aqueous vapors, a non-conducting packing in ice houses, safes and refrigerators, an ingredient of gunpowder and fireworks, and in the galvanic battery and electric light.

The iron in mineral springs is chiefly in the form of carbonate, the best form for medicinal purposes. Carbonic acid in the water keeps the carbonate of iron in solution, and when the water is at rest its surface shows a yellowish rust. Chalybeate springs are numerous, the more important being at Saratoga, New York; Harrogate, England; Santa Catarina, Italy, and St. Moritz, Switzerland.

The discovery of extensive underground deposits of calcium borate practically revolutionized the borax industry in this country. The greatest mine at present being worked is situated at Borate, in the southern part of the Mojave desert, 12 miles north of the Santa Fe railroad in California. This deposit takes its name from its discoverer, W. F. Coleman. The colemanite is developed by 2 shafts, which at present have been sunk 600 feet and levels opened from them. The shafts are equipped with cages operated by gasoline engines, each of 50 h. p. About 250 men are employed in the mine. The colemanite is obtained in lumps of various sizes, only a small percentage coming to the surface as fines. The mineral of lowest grade is sent to Marion, California, where it is calcined. The high-grade mineral and the product of the Marion plant are sent to Bayonne, N. J., where the most complete plant in the world has been constructed for making this into borax.

The sciency of chemistry, which deals with the composition and transformation of matter, had its origin in remote antiquity. In its earliest form it was purely empirical, a mass of disconnected facts which were brought to light in the natural course of development of various industries. In the extraction of metals from ores, in the preparation of drugs and medicines, in dyeing and the like, many chemical data were discovered, and of such facts a large number were known to the ancient Egyptians. Indeed, one plausible deriation of the word "chemistry" is from Khem, an early name of Egypt, which has reference to the blackness of the soil. With this name the Arabic word "chema," to hide, appears to have some relation, and when it is remembered that much ancient learning was preserved for us by Arabian scholars the description of chemistry as the Egyptian science or as the hidden or occult art, become intelligible. The modern distinction between elements and compounds was first clearly stated by Robert Boyle in 1161.